SCHOOL SCIENCE AND MATHEMATICS

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PIONEERS

"Blazers of Trails, They Pursue the Horizon"

Teachers, their wives, children and friends within traveling distance of Hudson are invited to "pioneer" to Historic Western Reserve Academy on March the Eighteenth. A cordial invitation is extended by Dr. Joel B. Hayden, Headmaster.

The day includes a morning program of inspiration, education and history at the cradle of religion, science and mathematics in the old Western Reserve of Connecticut, and an afternoon program which re-enacts our fore-fathers' heritage from the Indians—the making of maple sugar in a century-old "sugar bush."

Turn back the clock a hundred years and come to Hudson, Ohio, on this family educational day.

Dr. Hayden writes the following foreword to the program. The program itself follows.

FOREWORD

"There is no turning back today. The *old* we cannot fully recapture, save as an inheritance, a setting, and an inspiration. Since we *must* face unfolding life, individual and social, since change is inevitable, a conference of this nature is not only advisable, but necessary. We can and must do three things—establish a common fund of developing knowledge, promote an esprit de corps within a finely trained professional group, and finally, base our advance on a real friendliness, inspired by regular fellowship in play as well as research and teaching. May you find such opportunities on the WESTERN RESERVE ACADEMY campus which blends the old with the eternally new, the inevitably challenging."—JOEL B. HAYDEN.

PROGRAM—SPRING MEETING—OHIO MEMBERS AND GUESTS

Central Association Science and Mathematics Teachers

Saturday, March the Eighteenth, Nineteen Thirty-three

10:00 A.M. *Meeting* in the Old Chapel of Western Reserve (1836).
Chairman: Ernest O. Bower, East Technical High School, Cleveland; Vice-president, Central Association of Science and Mathematics Teachers.

10:20 A.M. *Musical Numbers*—Western Reserve Academy Glee Club.

10:45 A.M. *"Blazers of New Trails."*
Dr. Joel B. Hayden, Headmaster, Western Reserve Academy.

11:10 A.M. *"The Expanding Universe."* (Illustrated).
Dr. Jason J. Nassau, Professor of Astronomy, Case School of Applied Science.
Questions on Mathematics and Astronomy, Pupils, visitors, teachers.

12:00 M. *The Marimba.* Clyde Junior Holt, Soloist.
James W. Wickenden, Accompanist.

12:15 P.M. *"Old Hudson."*
Mr. A. N. Waite, Many-times Mayor of Hudson.

12:35 P.M. Luncheon—Academy Dining Hall.
(50¢. Please notify in advance the number in your party although we hope to be able to take care of any overflow. Address—R. B. Simon, Western Reserve Academy, Hudson, Ohio.)

2:00–4:30 P.M. *Hi Simon's Sugar Bush.*
Dr. Wm. G. Vinal, School of Education, Western Reserve University.
R. B. Simon, Western Reserve Academy.

5:00–7:00 P.M. *"Sugar-Off"* at the Old Congregational Church.

NATURE GUIDE SCHOOLS FOURTH ANNUAL SUGAR BUSH PARTY

2:00–4:30 P.M. Meet at North Woods to see gathering of sap and "bilin' down."
Photograph steps in Maple Sugaring.

2:00 P.M. *Nature Trip* starting at Sugar House to gather maple twigs, chips, and leaves for school work.

3:15 P.M. *Second Nature Hike* to see first harbinger-of-spring (Erigenia bulbosa), Claytonia, and other signs that the depression is over.

3:00–5:00 P.M. *Entertainment and Tea* at Evamere Hall Museum of Antiques, arranged especially for those not wishing to spend all the afternoon at the "Sugar Bush."

5:00–7:00 P.M. *"Siruping down"* and *"Sugaring-off"* at the Old Congregational Church. Supper served by Ladies who Know How.

(Reservation for the "Sugaring-Off" supper must be accompanied

by wampum to the amount of 50¢ (Fifty cents) on or before March 13th to assure place at this festive occasion. Last year two-hundred-and-sixteen (216) maple sugar enthusiasts made reservation. You have to experience one of these times to know why the Indians counted the sugar maple one of the gifts of the Great Spirit: why he made it an object of Nature Worship. Send reservations to William G. Vinal, School of Education, Western Reserve University, Cleveland, or to R. B. Simon, Western Reserve Academy, Hudson, Ohio.)

On Pioneer Day Hudson should look as though a World's Fair was on. This is a day for all teachers—academy, high school, college, elementary—Come on Scientists! And you Mathematics teachers multiply the crowd, integrate the gains, and divide the spoils!

CLARENCE D. McLOUTH

Members of the Central Association of Science and Mathematics Teachers who regularly attend the annual meetings and who were in attendance at the Cleveland meeting missed one member who has been an active participant for several years. Clarence D. McLouth of Muskegon High School was not there. The notice of his death, which occurred Sept. 27, did not reach the Necrology Committee until after the annual meeting.

Mr. McLouth had been a regular member of the Central Association since 1919, and was Chairman of the Chemistry Section in 1924. But his great contribution to education was made as a classroom teacher for fifty-two years, forty of which were at Muskegon. The editor of the *Muskegon Chronicle*, a former student of Mr. McLouth says:

> For every one of the literally thousands of youths, boys and girls, who came under the influence of this extraordinary character knew he or she had been in contact with a vibrantly dynamic personality. And that was something that may have been of more lasting benefit, sometimes, than the knowledge of natural science that went along with the experience.
>
> Mr. McLouth was an indefatigable worker, and he inspired work from youths of high school age that was the despair of other teachers. The secret was a personality the like of which is seldom encountered and that put him in a class by himself. A teacher who might frequently be found at his desk at six o'clock in the morning, and as likely as not at a late hour in the night, had an unanswerable argument for the amount of effort he required—and got—from his students.

Mr. McLouth was born near Adrian, Michigan, Nov. 21, 1860 and spent the first twenty-two years of his life on a farm. He graduated from the State Normal College at Ypsilanti in 1887. His education was continued by home study and at sixty-five years of age he took an extension course in chemistry from

the University of Chicago. He first taught a district school, then at the state school for the blind, after which he taught for five years at the Ypsilanti Normal and then went to Muskegon. While he taught the physical sciences, his hobby was botany. He spent his vacations studying and collecting the plants of the country near Muskegon.

THE COST OF EDUCATION DROPS

A recent news item from the United States Office of Education shows that the per capita cost of education has decreased twenty-two per cent in the past three years, carrying per capita costs to a lower level than for any year since 1922. Reductions have been brought about by reducing the outlay for teachers salaries, buildings, equipment, maintenance and operation.

No doubt many of these reductions were justifiable and necessary but in many cases reduction in governmental expenditures has extended only to the schools while other departments of government have continued to serve as rich spoils for those in power. This should be a sharp reminder to the teacher that his work is not complete so long as he gives only class room instruction. He has also been commissioned to educate the adults of his community, and he should lead an organized fight to retain all the educational advantages gained through the struggles of past years.

This month we present only one item of loss due to curtailments—that of books. This was one of the first points of attack because it seemed easy to show that unnecessary sums were being spent for books. The result is that the books now on hand have been literally worn to shreds. Pupils from first grade to college are attempting to study without textbooks. Free textbooks with pages falling out, backs missing, and reeking with disease germs are passed around from one student to another while class is in session. No one can study where such conditions prevail. The total outlay for textbooks, never a large percentage of the total educational budget, has been reduced to almost nothing. Without sufficient text and reference books time is wasted, discipline becomes more difficult, failures increase, and the schools become more congested. Better books are now available and at lower prices than ever before. These facts need to be brought to the attention of parent-teacher associations and other groups of parents. They will see that educational facilities are not denied the children because of a lack of suitable books.

THE PROGRESS OF ATOMIC PHYSICS

By Arthur Haut
Grover Cleveland High School, New York City

There is a little confusion in the minds of some students of chemistry as to the exact sequence of events which have led to our modern conception of atomic structure and behavior. For instance, while Moseley's work is well known, the fact that Barkla's researches with X-Rays provided the former with a foundation on which to begin is not often mentioned in popular descriptions of the work on the atom. The same may be said of Marsden's observations of H-Rays from which Rutherford later proved that the atomic nuclei of the lighter atoms could be disrupted. It was with the idea of combining the observations of earlier investigators with the work of Moseley, Rutherford, Bohr, et al. that the following brief outline of the progress of atomic physics is presented.

THE ELECTRON

Early developments. In 1858 Plucker discovered the cathode ray. He found that when a current of high voltage passed through a Geissler tube these rays were emitted in straight lines. In 1869 Hittorf and in 1879 Crookes both noticed that these cathode rays could be deflected by a magnet. In 1876 Goldstein proved that these same cathode rays could also be deflected by an electric field. The name "electron" was first used by Stoney in 1881, while in 1888 Hallwachs noted that a metal plate became positively charged when ultra-violet light was allowed to shine on it. This was later recognized to be due to the fact that negative particles were emitted by the plate making the latter positive.

J. J. Thomson. It was J. J. Thomson and Kaufman who, in 1897, announced that the behavior of the cathode rays, noticed by Crookes and Goldstein, could be attributed to the fact that they were actually *negatively charged particles possessing mass* and moving at a relatively high velocity. These two investigators calculated the velocity and specific charge of the cathode ray particles using the following general idea.

(1) A particle moving in a magnetic field must describe a circle which obeys the equation:

$$r \text{ (the radius)} = \frac{cv}{\gamma H}$$

where H is the magnetic field strength, γ the specific charge of the moving particle and v its velocity.

(2) In a uniform transverse electric field the moving particle must describe a parabola according to the equation:

$$\frac{y}{x^2} = \frac{1}{2} \cdot \frac{\gamma}{v^2} \cdot E$$

where y and x are axes of the parabola and E is the electric field strength.

Now in both of the above equations the only unknowns are the velocity and the specific charge. Since we have two equations both unknowns can be calculated. Thomson found the velocity, which depends on the tube potential, to be as high as one half the velocity of light.

The specific charge of the particles i.e. charge divided by mass (γ in the above formulae) was found to be 5.3×10^{17} E. S. U. (electrostatic units) per gram.

Now it happens that the specific charge of a hydrogen ion had been calculated before that time from a consideration of Faraday's Laws and the mass of the hydrogen atom. This was known to be 2.871×10^{14} E. S. U. per gram. Comparing this with the figure for the cathode ray particle it was found that the latter has a specific charge 1800 times as large. It appeared, therefore, that each of these particles, now known as electrons, must have a mass *one eighteen-hundredth that of the hydrogen atom*. These facts were later corroborated from other sources.

In 1896 Becquerel noticed that uranium ores gave forth rays which affected a covered photographic plate and in 1898 the Curies, investigating the source of these rays, discovered radium. It should be noted, in passing, that Mme. Curie did not actually isolate metallic radium until 1910.

Rutherford. In 1900, Rutherford and Dorn discovered the α, β, and γ radiations from radioactive substances. It was noticed that the β rays were deflected by a magnet and a determination of their specific charge and velocity by the method used for cathode rays, showed that they were essentially the same except that they moved with a much greater velocity, almost reaching that of light, while cathode rays which were also streams of electrons moved with about one half that speed.

Kaufman noted that the mass of the electron varied with its velocity and this later provided a proof of the correctness of

that part of the theory of relativity which points out that at high velocities the mass varies according to the formula:

$$m = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}}$$

where m_0 is the mass at small velocities, c the velocity of light and v the velocity of the mass, m_0. Note that if the velocity, v, of the mass, m_0, becomes $c/2$, i.e., one half the velocity of light, then the new mass, m, becomes 1.15 times greater. Also, v cannot be greater than c, otherwise the quantity under the square root sign will be negative. The inference is that there are no velocities greater than that of light.

Millikan. It had long been suspected from Faraday's work that the phenomenon of electricity was atomistic in nature, that is, that there probably was an elementary and very small charge which when multiplied many times produced recognizable effects called "electricity." In 1897 and 1898, Townsend and J. J. Thomson had tried to find the value of this elementary quantum of electricity by observing the motions of clouds of mist. Ehrenhaft in 1909 tried a similar experiment using not clouds but individual particles of various substances. Millikan developed and perfected these methods by using oil droplets *whose size was constant and would not change due to evaporation.*

The technique is somewhat as follows: A tiny oil droplet is introduced into a space between two parallel horizontal plates which act as a condenser. These droplets, since they are produced by frictional spraying have an electrical charge. The oil droplet on account of its weight starts falling. When a charge is given to the horizontal plates by a battery the droplet starts rising. The movement of the oil droplet can be observed for a long time with a microscope. The velocity of the drop can be calculated from the time taken to move between two points in the microscopic field. The relation shown by the equation:

$$\frac{V_2}{V_1} = \frac{QE - mg}{mg}$$

holds true, where v_2 is the velocity of upward motion, v the velocity of downward motion, m the mass of the particle, Q its charge, g the acceleration of gravity and E the electric field strength. The mass of the oil droplet can be calculated from a

formula known as Stokes' "Law of Fall," and since all the other variables are known, Q can be calculated.

Millikan found that the charge on the droplet varied, but *it was always a multiple of an elementary charge* which turned out to be 4.77×10^{-10} E. S. U. This is, therefore, taken to be the elementary quantum of electricity and is supposedly the charge on a single electron.

It appears then that thus far three sources of electron streams had been uncovered:

(1) The cathode ray

(2) The corpuscular radiation from metal plates when heated by ultra-violet light and

(3) The B-rays from radioactive elements.

The first two are artificially produced and have a lower velocity than the last. *In all cases the specific charge is the same.*

THE PROTON

Early developments. In 1886 Goldstein noticed that rays emanated from the cathode of a Geissler tube in a direction opposite to the cathode rays and it was later observed in 1906 by Gehrke and Reichenheim that the anode also emitted rays. The first were called canal rays, the second anode rays. Their velocity and specific charge was determined as in the case of electrons. They were shown to be particles *positively charged* moving at small velocities.

The peculiar thing about these positive rays was the fact that their specific charge was found to depend on the gas which was allowed to occupy the tube before evacuation. If hydrogen was used the specific charge of the positive particle was exactly that of the hydrogen ion. With mercury the specific charge was one-two hundredth of this value, pointing to the fact that the particles might be positively charged atoms of the element whose vapor occupied the evacuated tube.

Rutherford. When, in 1900, Rutherford noted the different types of radiations emitted by radioactive substances his attention was drawn to what are now called the α particles. They were shown by their deflection to have a positive charge and their velocity was about 5 per cent that of light. Their specific charge was found to be 1.44×10^{14} E. S. U. per gm. This is half that of the H ion (2.871×10^{14} E. S. U. per gm.).

In 1908 Rutherford and Geiger determined some very important facts connected with the α particle by means of the scin-

tillation method. These investigators allowed the α particle from a radioactive substance to strike a screen of zinc blend. The α particle on striking the screen emits a flash of light. Rutherford and Geiger, by the aid of a microscope, counted these flashes and were able to determine, therefore, the number of α particles emitted per second by a given radioactive substance. Nor was this all. After deflecting the β rays from the field they caused a metal plate to become charged by the impact of a known number of α particles. By dividing the total charge of the plate by the number of α particles they found the charge on each α particle. This was found to be double that of the elementary quantum of electricity (4.774×10^{-10} E. S. U.). But as noted above the specific charge of the α particle is half that of the H ion; hence the α particle has a *mass of four hydrogen atoms and a positive charge of two elementary units of electricity.*

C. T. R. Wilson. In 1912 Wilson produced the ingenious device by which he was able to photograph the path of α particles. As is well known, Wilson allowed α particles to pass into a chamber saturated with water vapor. The charged particles caused the moisture to condense along their path. Wilson's photographs showed that the path of an α particle is straight sometimes with a sharp bend at the very end.

J. J. Thomson. In 1913 Thomson developed what is known as positive ray analysis. It has been mentioned above that a charged particle in an electric field describes a parabola. All particles with the same specific charge *fall on the same parabolic curve.* If these are differently charged particles, *parabolas of different curvatures will be detected.* This is positive ray analysis. Using this method Thomson showed that neon contains particles of two different charges. This was the first experimental proof of the phenomenon of *isotopy* which was suggested by Soddy in 1910 as the reason for the deviation of some atomic weights from whole numbers.

Aston. In 1919 Aston refined Thomson's methods into what is now called mass spectroscopy. He proved with greater accuracy than was possible in Thomson's method that neon and also chlorine possess two isotopes. He examined many elements for isotopy and proved that the masses of positive ray particles are always multiples of the mass of the H atom.

Summing up, it was found that there are two distinct types of positive rays:

(1) The canal and anode rays, artificially produced in evacuated tubes and

(2) The α particles of radioactive substances which were proven to have a positive charge of two elementary quanta and a mass four times that of the H atom.

X-RAYS

Roentgen. In 1895 Roentgen discovered the remarkably penetrating rays now called x-rays. Roentgen noted that they were produced when the cathode rays emitted in an evacuated tube struck the glass sides of the tube.

It appears that these rays are produced whenever a stream of electrons is checked in its velocity by some object. In x-ray tubes the anti-cathode does the checking, in Roentgen's observation the glass of the tube acted as the check. These rays are also emitted by radioactive elements and are called gamma rays. They are not charged particles because they are not deflected by magnetic or electrical fields but they are characterized by their ability to penetrate objects opaque to ordinary light. X-rays from different sources have different penetrating power or hardness as it is called. In x-ray tubes the hardness depends on the tube potential.

Laue. It was early suspected that x-rays are of the nature of light and it remained for Laue to show *diffraction and interference phenomena* with them, phenomena characteristic of light waves. The difficulty in doing this up to 1912 was the lack of fine enough diffraction gratings. Laue solved this by using a crystal as a grating. It was understood that the regular form of crystals was due to an orderly arrangement of molecules with distances between molecules of a very small order (10^{-8} cm.). Crystals should, therefore, behave as diffraction gratings. In this manner Laue was able to take photographs of the interference lines produced by x-rays in passing through crystals.

Bragg. In 1913, W. H. and W. L. Bragg extended Laue's work. From interference photographs they were able to deduce the arrangement of molecules in a crystal. The cubic arrangement of the sodium chloride crystal was found to be the simplest, and when this had been ascertained they were then able by the use of such crystals whose internal space arrangements were known *to measure the frequency and wave length of x-rays.*

Barkla. In 1905 Barkla had observed that when x-rays were allowed to strike a chemical solid secondary x-rays were emitted

which had a characteristic hardness as measured by absorbing them. This secondary radiation contained rays characteristic of each element present. He also noted that the *hardness* of the rays *increased with the atomic weight* of the substance under investigation. He distinguished between two types of secondary rays, a hard radiation called K-radiation and a soft L-radiation.

Moseley. Barkla's work was the foundation for the now famous atomic number determinations made by Moseley in 1913. What Moseley did was *not* to measure the penetrating power of the secondary rays but to resolve this radiation into a *line spectrum* and to thus measure the wave lengths of these secondary rays. For this purpose he used a specially constructed vacuum spectrograph with a rotating crystal of the substance under examination as the anti-cathode. The spectrum photographs showed two distinct lines called the K and L lines.

Now Barkla had noticed the increase in hardness with atomic weight but Moseley found an *exact mathematical relationship* which showed that the elements could be arranged in a consecutively numbered series so that the square root of the frequency of the spectral line found on the photograph increased with the number assigned to the element. A number could thus be given to each element which is dependent on the square root of the frequency of the secondary x-rays it emits. This number was called the atomic number and agreed with the nuclear charge number for hydrogen and helium, and was here found to check up very closely with the nuclear charge number obtained from a study of the scattering of α particles passing through thin metal foils (see below).

RADIOACTIVE DISINTEGRATION AND ATOMIC THEORIES

Rutherford. Rutherford and Dorn's observation, in 1900, of the various rays proceeding from radioactive substances has already been mentioned. In 1902 Rutherford and Soddy put forward their disintegration theory based on the now familiar idea that radioactive substances, by expulsion of α and β particles, undergo a series of successive disintegrations finally ending with lead.

In 1903 Ramsay and Soddy spectroscopically showed that helium was produced from radioactive emanations but it was not until 1909 that Rutherford and Royds definitely proved that the α particle was a charged helium atom. They enclosed some radium emanation in a thin walled glass tube, thin enough

for α particles to penetrate. This thin walled tube was completely surrounded by a thick walled evacuated tube. After some time the presence of helium was detected inside this *outer tube.*

In 1911 Rutherford propounded a theory of atomic structure which is the basis of our belief today. Rutherford saw each atom as consisting of a positively charged nucleus, in which was concentrated the mass of the atom, surrounded by moving negatively charged electrons. In this theory, the concept that the mass of the atom is centered in the nucleus is extremely important and Rutherford came to this conclusion from a study of what appears to be a rather simple experiment. He noticed that when α particles were allowed to pass through thin metal foils most of them passed through with practically no deflection, probably due to the fact that the α particles find only electrons with relatively large spaces between them in their path through the foil. Now and then, however, much larger deflections occurred, 90° or more. This, Rutherford concluded, was due to the α particle coming within the repulsive range of a much greater positive charge, i.e. the charge due to the protons packed in the nucleus. It may be noted in passing that Rutherford is responsible for the term "proton."

In 1920 Chadwick was able by the use of the same idea to estimate the positive charge in the nucleus of some atoms. It is evident that the amount of deflection noted by Rutherford is dependent upon the magnitude of the nuclear charge. Chadwick calculated the nuclear charge of platinum, silver and copper and came very close to Moseley's atomic numbers for these elements, close enough to act as a confirmation of Moseley's work.

Bohr. It remained for Bohr, in 1913, to take Rutherford's idea of the atom and by a clever use of mathematical physics to account for several phenomena which up to that time had not been clearly understood.

(1) Bohr, on the assumption that the electrons move in orbits around the nucleus, *calculated the radius of the orbit of the free electron in the hydrogen atom.*

(2) He also calculated the energy possessed by the revolving electron.

(3) His model of the hydrogen atom *explained the lines in the spectrum* of that element and led to a better understanding of spectral phenomena in general.

The Rutherford-Bohr atom primarily *explained spectral lines*

and did not attempt to *explain chemical reactions*, which became the contribution of the Lewis-Langmuir theory.

Balmer. To understand what Bohr did it is necessary to go back to 1885 when Balmer noticed that the frequencies of the various lines in the hydrogen spectrum were not haphazard, neither did they differ by whole numbers but were *related to the reciprocals of the differences of whole numbers*, according to the formula:

$$V = R\left(\frac{1}{n^2} - \frac{1}{m^2}\right)$$

where R is a constant known as the Rydberg constant, equal to 3.291×10^{15}, and n and m are whole numbers, n having the value 2 for the ordinary hydrogen spectral lines while m is a whole number depending on the particular hydrogen line referred to.

Planck. Now coming to 1900, Planck, by a study of the radiation of black bodies, brought forward the idea that energy such as radiant energy, is emitted *not continuously but discontinuously*, in minute parcels, so to speak, called "quanta." These "quanta" of energy are not equal for every kind of vibration. They are greater the higher the frequency; that is, the ratio of the amount of one of these quanta of energy to the frequency is a constant called h, or

$$h = \frac{e}{v}$$

where h is Planck's constant—equal to 6.545×10^{-27} ergs per second, e is the energy and v the frequency.

Bohr. Now Bohr's idea was that the single electron of the hydrogen atom revolved in its special orbit but under certain conditions when the electron becomes agitated in any way by, for instance, the addition or liberation of energy, the electron might start revolving *in another orbit* of different radius. Thus, a liberation of energy by the hydrogen atom, corresponds to a change in the orbit of the electron and when such a change occurs, Bohr assumed that a single light quantum is liberated which represents itself as a *spectral line.* A jump from an orbit of normal radius to a still larger orbit would result in the liberation of more quanta and hence lines of different frequency would be seen.

Working on this assumption, Bohr *theoretically* derived a formula for the frequency of spectral lines in terms of light quanta which is similar to Balmer's equation (see above) which had been derived *empirically.*

Bohr thus accounted for the lines in the spectra of the atoms by the *jumping of an electron from one orbit to another.*

From Bohr's formula it was possible to calculate the frequency not only of the *known* lines in the visible spectrum of hydrogen but also of certain lines which were *not known* at the time but were later found in 1914 by Lyman, in the ultra-violet region. Other calculated lines were found in the infra-red range by Brackett in 1922. This provided a beautiful confirmation of Bohr's work.

Rutherford. It has been pointed out above how Rutherford showed that radioactive substances emitted positively charged helium nuclei, electrons and gamma rays. It was observed that this disintegration was independent of external conditions and that the rate of decay could not be changed by any external influence. The only atoms which showed this disintegration were the atoms of the heavy elements, radium, uranium, thorium, etc. In 1919, Rutherford accomplished the remarkable feat of causing the disruption of nitrogen, a *non-radioactive* light element. He did this by bombarding nitrogen with α particles from a radioactive substance. What happens is that the nitrogen nucleus explodes and charged hydrogen atoms or protons are produced. The charged hydrogen atoms were detected by measurements of their deflection in magnetic and electric fields. However, the total disruption was shown to be very small and it has been calculated that a year's bombardment would produce a thousandth of a cubic centimeter of hydrogen gas.

Following these first experiments, Rutherford and Chadwick have also been able to effect the disintegration of atoms of other elements such as fluorine, neon, sodium, phosphorus, etc.

In connection with this work, it should be observed that Marsden, in 1914, had noted the fact that α particles when allowed to bombard hydrogen atoms caused the hydrogen atoms to become ionized, that is, they stripped the hydrogen atom of its planetary electron. It was this phenomenon that Rutherford was investigating when he noted the disruption of nitrogen nuclei.

Another interesting point is the fact that the reported transmutation of mercury into gold by Miethe, in 1925, by adding an electron to the mercury nucleus, has never been substantiated.

These experiments on atomic disintegration have led physicists to adopt Prout's basic idea which he propounded as long ago as 1815, i.e. that the nucleus of the atom is composed es-

sentially of *hydrogen*. The nucleus supposedly contains charged hydrogen atoms grouped so as to form α particles, groups of four hydrogen atoms with two positive charges. Atoms of elements whose atomic weight is not exactly divisible by four are assumed to contain individually charged hydrogen nuclei in addition to the helium grouping.

Langmuir. In 1919, Langmuir propounded his well-known theory of the structure of the atom. Lewis had previously pictured each atom as consisting of electrons stationed at the corners of a cube. With more than eight electrons another cube surrounding the first would be started. This was called the "octet" theory of valence because of the possibility of there being only eight electrons for each cube.

Langmuir incorporated this idea of a stable number of eight electrons and also borrowed from Bohr's theory by assuming that the electrons revolved in orbits around the positive charge equal to the atomic number in the center nucleus. But, what is most important, Langmuir's atom tries to explain *chemical activity* by postulating that the outer ring of electrons, if it did not already contain the stable number of eight, attempted to give or take a sufficient number of electrons to satisfy this stable number. Active elements had an outer ring of less than eight electrons, inert elements such as the inert gases had a stable ring of eight or in the case of helium, the stable ring consisted of only two electrons.

It is important to note that Langmuir's atom did not attempt to explain spectral lines. This, the Bohr atom had done.

In 1922 Bohr explained the complete grouping of the electrons around the nucleus for all ninety-two atoms, on the basis of their spectral lines. This grouping also coincides with the periodic system because it postulates the following number of electrons in successive orbits: 2, 8, 8, 18, 18 and 32. This makes six orbits, called the K, L, M, N, O and P orbits and is equal in number to the six periods of the periodic table.

WAVE MECHANICS

In 1924 Louis de Broglie deduced from purely *theoretical* considerations that a stream of electrons must have a wave motion associated with it, that an electron which always had shown only corpuscular properties must also be accompanied by some sort of wave like that of light. The idea of a wave motion and a corpuscle joining forces, so to speak, was not entirely new. In

1905 Einstein, for instance, had suggested that light waves were made up of units called "photons" and applied Planck's quantum ideas to these units. De Broglie calculated the wave length of an electron and deduced formulas connecting the energy and momentum of the electron with the frequency and velocity of the wave.

In 1927 came *experimental* verification of de Broglie's ideas. Davisson and Germer showed that electrons like light waves could be reflected from the surfaces of crystals.

G. P. Thomson proved that electrons were *diffracted* on passing through thin sheets of various metals. *Diffraction is characteristic of wave motion.*

At about the same time Schroedinger in his theory of wave mechanics, tried to explain *all* atomic and spectral phenomena by assuming a wave instead of a corpuscular motion for the electron. This was done on a purely theoretical basis using de Broglie's work as a starting point. According to Schroedinger, matter is a region filled with waves and although his mathematics becomes very involved, he is able to deduce the spectral behaviour of many atoms by means of his theory.

Heisenberg seems to have attacked the problem of atomic structure by reasoning only from facts which could be *observed*, for example, the frequencies of spectral lines. He discarded theoretical positions of electrons in the atom, positions which could not be detected, started only with *actual facts* and by the use of the higher mathematics of wave mechanics was able to explain, for instance, the spectrum of helium. Another result of the ideas of this new aspect of atomic structure has been the discovery, in 1929, by Bonhoefer and Harteck of two forms of hydrogen, a para and an ortho form.

Today, therefore, atomic physics finds itself slowly being carried away by the new idea of wave mechanics. The older ideas of Rutherford and Bohr are gradually being modified by a newer group of mathematical physicists.

BIBLIOGRAPHY

1. Arthur Haas, *The World of Atoms*, Van Nostrand and Co., New York City, 1928.
2. Leo Graetz, *Recent Developments in Atomic Theory*, E. P. Dutton and Co., New York City, 1922.
3. Louis de Broglie, "Waves and Corpuscles," Annual Report of the Smithsonian Institute, 1930, pp. 243.
4. Ernest Rutherford, "*Radioactive Substances and Their Radiations*," Cambridge University Press, Cambridge, 1913.

5. R. A. Millikan, *The Electron*, University of Chicago Press, Chicago, 1924.
6. F. Soddy, *The Interpretation of Radium and the Structure of the Atom*, Putnam, New York City, 1921.
7. Bertrand Russell, *The A B C of Atoms*, Dutton, New York City, 1923.
8. F. W. Aston, *Isotopes*, Edward Arnold and Co., London, 1924.
9. G. N. Lewis, *Valence and the Structure of Atoms and Molecules*, Chemical Catalogue Co., New York City, 1923.
10. Niels Bohr, *The Theory of Spectra and Atomic Constitution*, Cambridge University Press, Cambridge, 1924.
11. Kramers and Holst, *The Atom and the Bohr Theory*, A. A. Knopf, New York City, 1923.
12. A. H. Compton, *X-Rays and Electrons*, Van Nostrand and Co., New York City, 1926.
13. Arthur Haas, *Wave Mechanics and the New Quantum Theory*, Constable and Co., London, 1928.

EINSTEIN DEVELOPS NEW QUANTUM MECHANICS AND DISCUSSES SEMIVECTORS AND SPINORS

Prof. Albert Einstein's first paper on the new quantum mechanics is soon to appear under the title: "Semivectors and spinors."

He has just allowed his colleagues in theoretical physics at the California Institute of Technology here to have an advance view of some of the ideas contained in this forthcoming paper which will be published in the Proceedings of the Prussian Academy at Berlin with Dr. Walter Mayer as the collaborating author.

Prof. Einstein is careful to explain that most of the results had already been discovered by other workers. But he wrote the forthcoming paper at the request of his friend, Prof. Paul Ehrenfest of Leiden, to clarify this little known subject.

His discussion with the theoretical physicists was, of course, technical. To make it easier for his American listeners Einstein spoke English. This is the first extended discussion he has delivered in English. Usually he chooses to use German in order to express himself more precisely and clearly. His English is, however, quite good.

Semivectors are related to vectors in somewhat the way that imaginary numbers are related to real numbers. The spinors are restricted semivectors. The vector concept is fundamental in relativity because it enables one to avoid irrelevancies. Thus it helps discover new laws.

The semivector may suggest new physical laws also for it has the same simplifying properties as the vector. As in the case of the vector, the semivector can furnish tensors. The famous equations of Lorentz can be written for semivectors but no important change is involved. The Dirac equation for an electron can be derived in an elegant manner but Prof. Einstein pointed out that it was not the simplest case of its type.

He said it would be interesting to study the simplest case. Then he went on to say that semivectors could be used to advantage in generalized relativity, but that unlike vectors they led to complicated equations.

When Prof. Richard C. Tolman, of the California Institute of Technology, asked for a physical description of a semivector, Prof. Einstein confessed he had been unable to think of any geometrical or physical picture but added that with mathematical analysis the subject could be handled with great ease.—*Science Service.*

SCIENCE FOR THE CONSUMER

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THE PROBLEM

The increase in the use of scientific terms in publications intended for consumers leads one to question the adequacy of present courses of study in covering this practical aspect of science. The purpose of this study was first, to discover the scientific terms occurring in publications of Consumers' Research Incorporated; and second, to classify these terms for the benefit of persons interested in the development of science for consumers. The classification will be useful to the teachers of science and home economics, and to the curriculum worker. No attempt was made to organize the terms or to determine grade placement.

PROCEDURE

This study limits itself to the publications of Consumers' Research Incorporated because the bulletins of this organization are the most readable, comprehensive, and unbiased writings for the consumer. Only such terms were recorded which might reasonably be included in the subject matter of the several sciences. Each term was placed on a card together with the commodity name under which it occurred. This procedure yielded 718 cards. Due to duplication of the same term under more than one commodity the total number of terms was reduced to 349.

It was necessary to make a number of tables or classifications. The first was a classification of terms as they occurred by commodities. The cards were sorted under commodity headings, alphabetized, and then recorded. The second was a classification of terms arranged alphabetically, followed by the names of the commodities in connection with which they were used. The third was the arrangement of the terms and commodity listings under the various school subjects. The cards were sorted according to school subject and division of the subject, then alphabetized and recorded. Due to space limits only the second of these tables is given in this paper. At the conclusion of the above classifications a summary table was made. This table lists the

terms under subject matter topics and gives their frequency of occurrence in commodities discussed.

Many terms were found which were too broad to be useful in any but general science lists. Some terms were too technical to be useful in any but a more specialized subject, for example, the term *superheterodyne*. In general, the terms included were scientific and of such common usage that any forward looking teacher of science would want to consider them for inclusion in a course of study.

DISCUSSION OF THE DATA

The summary table (Table I) shows to what extent the main topics of the several sciences occur in the consumer bulletins studied. The number of terms listed under physics is slightly larger than those listed under chemistry. However, the importance of the chemical terms is demonstrated by the large number of commodities in connection with which they occur; though fewer than physics, the chemical terms are more frequently and more widely used. The biology and home economics lists are strong. The health and hygiene terms are quite numerous but many are duplications of those listed under chemistry or human biology. No listing was made of the terms that occur in general science because they were included under biology, chemistry, and physics. The biological terms indicate the larger usefulness of the human rather than the animal aspect so often stressed in the average course.

It is reasonable to believe that the fundamentals of science, as are suggested by these terms, should be known by the layman. Such terms enter into the conversation of many people. An understanding of the terms would aid the average consumer in reading advertisements, and in making wise selection and purchase of goods. The schools must include more of the practical aspects of science if they are to help in educating the consumer. Judging from the number of statements and explanations of scientific terms occurring in the bulletins, it is clear that the consumer has not had the benefit of practical scientific training.

A study of the final alphabetical list of scientific terms reveals special emphasis on some terms and groups of commodities, for example, the term *vitamin* in connection with *foods*. Some scientific topics such as *building materials* do not appear to receive the emphasis which they should have. The data indicate that present distribution of emphasis in elementary courses of chem-

istry is contrary to the needs of the pupil, at least if he is to function as a consumer. The number of organic chemistry terms is proof of needed changes in the average chemistry course which devotes about 90 to 95% of the time to the inorganic side. There is an abundance of physical terms which should receive attention in physics courses or in general science courses.

There is a need for further study of the occurrence of scientific terms in publications widely read by consumers, such as: a group of representative magazines; mail order house catalogues; newspaper advertisements; and government publications.

The data can be used in the following ways: first, as a basis of a course of science for consumers; second, as a basis of a course in science for specialists and instructors of secondary and college courses in home economics; third, as a check list by any teacher of science who feels he is neglecting the practical aspects of science in his course; fourth, as a basis for building vocabulary tests in general science or other subjects covered; and fifth, as an aid in selecting practical applications of scientific facts and principles.

TABLE I

SUMMARY OF OCCURRENCE OF SCIENTIFIC TERMS IN BULLETINS FOR CONSUMERS

Topic	*Number of scientific terms found*	*Number of commodities in which terms are used*	*Topic*	*Number of scientific terms found*	*Number of commodities in which terms are used*
Biology	52	78	Home Economics	44	88
Animal	3	4	Foods	33	71
Human	39	60	Textiles	11	17
Plant	10	14	Physics	95	177
Chemistry	85	203	Electricity	12	18
Acids and Bases	18	60	Heat	12	42
Carbon Compounds	7	18	Light	16	22
Sodium Compounds	13	35	Mechanics of Solids	12	18
Sulphur Compounds	2	6	Mechanics of Fluids	10	18
Metallic Earths	10	16	Mechanics of Gases	24	44
Metals	15	30	Sound	5	7
Organic Chemistry	20	38	Electro Chemistry	4	8
Health and Hygiene	70	118	Unclassified	5	—
Drugs and Medicine	40	68			
Diseases and Treatment	24	35			
First Aid	6	15			

Scientific Terms in Consumer Bulletins and the Commodities to Which They Are Related

1. Abrasive: furniture polish, knife sharpener, laundry soap, metal cleaner, rubber tile, scouring powder, soap powder.
2. Absorption: sanitary napkins, silk.
3. A.C. Current: household appliances, radio.
4. Acetic acid: acids, antiseptics, bleaching agents.
5. Acid: concrete, enamelware, food, ink, linoleum, motor oil, pressure cooker, rubber tile, silk.
6. Acid-alkaline balance: drugs.
7. Acidosis: drugs.
8. Acoustics: radio sets.
9. Adulteration: canned goods, catsup, cereal, fruit juices, jellies, olive-oil, preserves, silk.
10. Aerodynamics: automobiles.
11. Alimentary tract: baking powder, yeast.
12. Alkali: coffee, laundry soap, toilet soap, water softener.
13. Alkaline: food, ink, linoleum, metal cleaner, paint, soap powder, water softener, aluminum ware.
14. Alkaline antiseptic: drugs.
15. Alkali carbonate: cocoa, chocolate.
16. Alkali metal salt: fire extinguishers.
17. Alloy: acids, aluminum ware; enamelware, pewter, silverware.
18. Aluminum salts: baking powder, fire extinguishers, paint.
19. Amalgam: dental filling.
20. Ammonia: brushes, fertilizer, floor wax, refrigerator.
21. Ammonium hydroxide: caustics.
22. Amplification: radio.
23. Analine dye: blueing; hair dye, woolen.
24. Anhydrous sodium bicarbonate: boiler compounds.
25. Anti-acid effect: mineral water.
26. Antiseptic: bleaching agent, disinfectant, hair tonic.
27. Antimony: enamelware, furniture polish.
28. Anti-rachitic vitamin: foods, fruit.
29. Anti-scorbutic vitamin: food, milk.
30. Anti-sterility vitamin: cereals, food.
31. Arsenic: fruit, insecticide, hair dye, sugar.
32. Asbestos: fireproofing, insulation.
33. Aspirin: drugs.
34. Asphyxiation: furnace, gas stove, refrigerator, water heater.
35. Atmospheric pressure: hot air furnaces.
36. Audio frequency: radio.
37. Automatic volume control: radio.
38. Automatic shock absorbers: automobile.
39. Automatic switch: coffee machine, electric iron, toaster.
40. Bacteria: acidophilus, disinfectants, milk, refrigerator.
41. Bacteriacidal power: ultra violet light, disinfectants, mouth wash.
42. Bacterial toxin: frozen foods.
43. Base: cosmetics.
44. Basic fat: toilet soaps.
45. B.T.U.: coal, gas, furnaces, household appliances, oil, stoves, radiators, refrigerators, steam boiler, water heaters.
46. Battery: radio, automobile.

47. Bearings: vacuum cleaners.
48. Belladonna: drugs.
49. Benzoic acid: deodorants.
50. Biologically standardized: cod liver oil, foods.
51. Bleaching agents: cosmetics, disinfectants.
52. Brake horsepower: automobiles.
53. Bromate salts: cereals, drugs.
54. Builder: laundry soaps, soap powders.
55. Calcification: cereals.
56. Calcium hypochlorite: bleaching agents, disinfectants.
57. Calcium chloride: coke, fire extinguishers.
58. Calcium oxalate: fruits, vegetables.
59. Calcium salts: cereals, water softeners.
60. Calandered: cotton.
61. Calorie: foods, reducing preparations.
62. Calyx parts: fruits.
63. Cancer: laxatives, radium nostrums.
64. Carbohydrates: canned foods, cereals, foods, sugar.
65. Carbon dioxide: fire extinguishers, soft drinks.
66. Carbonization: coke.
67. Carbon monoxide: air conditioning unit, automobiles, cook stoves, gas heaters, water heaters.
68. Carbon tetrachloride, cleaning agents, cotton, dry cleaning, fire extinguishers.
69. Carotene: foods.
70. Carrier waves: radio.
71. Catalysis: fire extinguisher.
72. Caustic potash: caustics, cuticle remover.
73. Cellulose: cereals, disinfectants, sanitary napkins.
74. Cellulose acetate: rayon, textiles.
75. Chemical analysis: foods, drugs.
76. Chemical warning agent: refrigerator.
77. Chemical wash: fruits, rugs.
78. Chlorine: bleaching agents, coke, fire extinguisher, rugs.
79. Chloroform: cleaning agents.
80. Chrome tanned: shoes.
81. Chromium plate: electric iron.
82. Citric acid: gelatin, soft drinks.
83. Clinic: disinfectant.
84. Caffein: coffee, soft drinks, drugs.
85. Cold storage: eggs, fruits.
86. Combustion: coal, oil.
87. Commutator: vacuum cleaners.
88. Compression ratio: automobiles, gasoline.
89. Compressor: refrigerators.
90. Convection currents: gas heater, humidifier, hot air furnaces, refrigerator.
91. Corrosion: automobile, enamelware, hot air systems, household oil, ink, pipe, refrigerators, stainless steel, table grills.
92. Crystalline substance: disinfectants, honey.
93. Cubic centimeter: ink.
94. Cultured milk: dairy products.
95. Cupra ammonium process: rayon, textile.
96. Decomposition: canned foods, catsup, frozen foods.
97. Deodorant: refrigeration, cosmetics, disinfectants.
98. Density: maple syrup, oil.
99. Dermatosis: drugs.
100. Desensitization: milk.
101. Detector: radio.
102. Dextrose: sugar.
103. Deficiency diseases: foods, cereals.
104. Diffused light: lighting systems.
105. Disinfecting agent: sweeping compounds, toilet soaps.
106. Distillation: coal, water.

107. Down draft carburetor: automobiles.
108. Drying oil: cleaning agents, paint.
109. Dynamic speaker: radio.
110. Electrolitic action: aluminum ware, metal cleaner, pipe.
111. Electroplating: metal cleaner, silverware.
112. Electrolyte: ink, radio battery.
113. Electromagnetic switch: automobiles.
114. Electric shock: mechanical exerciser (see shock hazard)
115. Element: electric iron, radiant heater.
116. Emulsion: milk, rubber tile, plaster.
117. Essential elements: food.
118. Essential oil: cosmetics, tooth paste, soft drinks.
119. Ethane: gas stoves.
120. Ether: anesthetic, cleaning agent.
121. Ethyl bromide: refrigerators.
122. Ethyl chloride: refrigerators.
123. Exchange silicate process: water softeners.
124. Feldspar: abrasives.
125. Fermentation: honey, tea.
126. Ferric chloride: drugs.
127. Filament: electric light, radio, radio tube.
128. Filter paper: coffee machines.
129. Focus: camera.
130. Focal length: camera.
131. Food calcium: foods.
132. Food constituent: cereals.
133. Food phosphorus: foods.
134. Foot candle: lighting system.
135. Formalin: cereal, deodorant, drugs, hair tonic.
136. Formula: cereals, drugs.
137. Free wheeling: automobiles.
138. Frequency controlled: clocks.
139. Fuller's earth: abrasives.
140. Functional disability: drugs.
141. Fungus: drugs.
142. Fumigant: drugs, exterminators.
143. Galvanize: iron work, lath.
144. Gastric juice: disinfectant, baking powder.
145. Gastro-intestinal infection: cereals, foods.
146. Germicidal agent: laundry soap, soap powder, drugs.
147. Glandular extract: drugs.
148. Glaze: enamelware.
149. Glucose: sugar.
150. Goiter: food, salt.
151. Gram: ink, silverware.
152. Gravity: hot air furnaces, hot water system, lubricating oils.
153. Heat conductivity: shoes.
154. Hemoglobin: ultra-violet ray apparatus.
155. Horological institute: clocks.
156. Horsepower: automobiles.
157. Hydrocarbon: gas stoves, laxatives.
158. Hydraulic brakes: automobiles.
159. Hydraulic shock absorbers: automobiles.
160. Hydrochloric acid: acids, cleaning agents, deodorants, enamelware, fire extinguisher.
161. Hydrocyanic acid: exterminators, insecticide.
162. Hydrometer: battery, oil.
163. Hydrogen peroxides: bleaching agent, disinfectant.
164. Humidity: air conditioning unit, films, furnaces, radiators.
165. Humus: fertilizers.
166. Ignition: automobiles, oil burners.
167. Impermeability: rubber tile.
168. Infection: drugs.
169. Infra-red ray: ultra-violet light.
170. Infusion: tea.
171. Infusorial earth: abrasives.
172. Inactivation: food.
173. Isobutane: gas stove.

174. Inorganic matter: gelatine, laundry soap, soap powder.
175. Insoluble: water softener.
176. Insulation: boiler, coffee maker machine, cook stove, food mixer, furnace, household appliances, oil burners, pipe, refrigerator, roofing, table grill, water heater.
177. Intestinal putrefaction: milk.
178. Insulin: drugs.
179. Iodine: food, salt.
180. Irradiation: cereal, ergosterol, food, ultra-violet light appliances.
181. Javelle water: bleaching agents.
182. Kilowatt hour: electric stoves, household appliances: refrigerators.
183. Lactic acid bacillus: milk.
184. Lanolin: cosmetics.
185. Larvae: insecticide.
186. Lead acetate: metal polish.
187. Lead poisoning: pewter, paint, gasoline.
188. Legume: food.
189. Linear magnification: field glasses.
190. Lubrication: automobiles, vacuum cleaners.
191. Magnesium: magnesite, pipe, water softener.
192. Magnetic pick up: radio.
193. Mercerized: cotton.
194. Mercury salts: cosmetics.
195. Metallic dye: hair dye.
196. Metallurgist: pewter, silverware.
197. Methyl bromide: refrigerators.
198. Methyl chloride: refrigerators.
199. Microscope: dinnerware, silk.
200. Micro-organism: mouth wash.
201. Mille-microns: food.
202. Mineral matter: silk.
203. Mineral salt: canned food, cereal, food.
204. Mineral wool: insulation materials.
205. Mixed diet: food.
206. Mucin film: tooth paste.
207. Mucin plaque: tooth paste.
208. Mucus membrane: disinfectant.
209. Muntz metal: pipes.
210. Neutral salt: food.
211. Neutral soap: blankets, drugs, silk.
212. Nitro-benzene: furniture polish.
213. Nitro-cellulose: rayon.
214. Non-corrosive: disinfectant.
215. Oak tanned: shoes.
216. Octane rating: gasoline.
217. Opaque: enamelware.
218. Opiates: radium nostrums.
219. Oral antiseptic: tooth paste.
220. Oral mucus membrane: tooth paste.
221. Organisms: meat.
222. Orthodichlorobenzene: cleaning agents, metal polish.
223. Orthopedics: hearing aid.
224. Oxalic acid: acids, bleaching agents, fruits, metal polish, vegetable.
225. Oxidation: metal cleaner, insulating materials.
226. Ozone: ultra-violet light, ventilating devices.
227. Pasteurize: food, milk.
228. Pathogenic-disability: foods.
229. Pathogenic-organism: disinfectant, yeast.
230. Pellagra: food.
231. Perspiration: silk.
232. Petrol-cracking: gasoline.
233. Phenol coefficient: disinfectants.
234. Phosphoric acid: jelly, preserves, fertilizers, metal cleaner.
235. Phosphorous assimilate: viosterol.
236. Potassium bromide: cereals.
237. Potassium chlorate: tooth pastes.
238. Potassium permanganate: drugs.

239. Precipitate calcium phosphate: tooth pastes.
240. Potash: fertilizer.
241. Preservatives: cereals, foods, fruit juice, meat, syrup, soft drinks.
242. Pressure gauge: pressure cookers, boilers.
243. Prism binocular: field glasses.
244. Prophylaxis: viosterol.
245. Proprietary repellant: exterminator, insecticide.
246. Radio-activity: nostrums.
247. Radio frequency: radio sets.
248. Radiation: oil burners, radiator, steam heating systems.
249. Refrigerant: air conditioning, refrigerators.
250. Relative humidity: air conditioning, cool, humidifiers.
251. Resilience: rubber tile.
252. Resorcin: hair tonic.
253. Rickets: viosterol.
254. R. P. M.: automobiles.
255. Rottenstone: abrasive.
256. Saccharine: mouth wash, soft drink.
257. Safety fuse: coffee machine.
258. Safety valve: pressure cooker, steam boiler.
259. Sanfordizing: shirts.
260. Salicylic acid: drugs.
261. Scanning disc: television.
262. Screen grid: radio sets.
263. Selective sliding gear: automobiles.
264. Selectivity: radio sets.
265. Sensitivity: radio sets.
266. Shock hazard: electric grill, electric toaster, food mixer, vacuum cleaner, waffle iron, water heaters.
267. Short wave: radio sets.
268. Shatter proof glass: automobiles.
269. Silichrome steel: gasoline.
270. Silver sulphide: metal cleaner.
271. Skin glands: cosmetics.
272. Slaked lime: white wash.
273. Snubbing action: automobiles.
274. Soda-lime process: water softener.
275. Sodium bicarbonate: deodorant, drugs, fire extinguisher, mouth wash, tooth paste.
276. Sodium-carbonate: bath salts, bleaching agent, caustics, cosmetics, metal cleaner, scouring powder, sodas, water softener.
277. Sodium citrate: soda.
278. Sodium fluoride: insecticide.
279. Sodium hydroxide: caustics, disinfectant, water softener.
280. Sodium malate: salt.
281. Sodium perborate (borax): bath salts, water softener.
282. Sodium sesqui-carbonate: sodas, metal cleaner.
283. Sodium silicate: boiler compound, eggs, soda, toilet soap.
284. Sodium thisulphate: metal cleaners.
285. Solarization: ultra-violet light appliances.
286. Solubility: disinfectant, laundry soap, silk.
287. Solvent: cleaning fluids, furniture polish, laundry soap, metal cleaner, soap powder.
288. Spontaneous combustion: cleaning agent, coal, floor oil, floor wax.
289. Stainless steel: knives, knife sharpeners, metalware.
290. Streamlining: automobiles.
291. Strichnine: drugs.
292. Sterilization: mouth wash.
293. Stereoscopic photography: camera.
294. Suction: vacuum cleaner.
295. Superheterodyne: radio sets.
296. Sugar of lead: drugs.
297. Sulphate: baking powder, coal.
298. Sulphur dioxide: canned foods, cereals, dried fruits, refrigerators.
299. Synthetic oil: bath salts, soft drinks.

300. Synthetic fiber: rayon, silk.
301. Tannic acid: drugs, ink, tea.
302. Temperature compensation: automobiles.
303. Tensile strength: cotton, silk, insulation.
304. Tetraethyl lead: cleaning agent.
305. Thermal equivalent: refrigerator.
306. Thermostat: automobile, dampers, electric iron, electric radiators, furnace blowers, electric coffee making machine, gas furnace, gas stove, heating pad, mechanical stoker, oil burner, heating system, waffle iron, water heater.
307. Thyroid extract: reducing preparation.
308. Thyroxin: drugs.
309. Thyroid gland: foods.
310. Tincture of iodine: disinfectant.
311. Titanium zinc: paint.
312. Tone control: radio sets.
313. Tone quality: piano, radio sets.
314. Toxic action: baking powder, can opener, dry cleaning machine, gasoline, milk.
315. Toxic solvent: cleaning agents.
316. Translucent: dinnerware, lighting.
317. Transformer: radio sets.
318. Transmission: automobiles.
319. Trench mouth: mouth wash, tooth paste.
320. Trisodium phosphate: bath salts, boiler compounds, laundry soap, scouring powder, soap powder, soda, metal cleaner, water softener.
321. Unbleached: cereal.
322. Ulceration: depilatories, cereal.
323. Ultra marine blue: analine dye.
324. Ultra-violet ray: apparatus, hair tonic, drugs, food, glass.
325. Vaccine: drugs.
326. Vacuum: carpet sweeper, coffee, coffee grinder, vacuum bottle, vapor heater.
327. Vacuum clutch control: automobile.
328. Vacuum tube: radio.
329. Viosterol: cod liver oil.
330. Viscose: rayon.
331. Viscosity: automobiles, cleaning agents, furniture polish, household oil, lubricating oil.
332. Vitamin A: fruits, vegetable, yeast.
333. Vitamin B: cereal, cod liver oil, laxatives, reducing preparations.
334. Vitamin C: cereal, food, fruits, fruit syrup, vegetable.
335. Vitamin D: cereals, fruit, fruit syrup, foods, milk, pickles, pressure cookers, tea.
336. Vitamin E: cereal, cod liver oil, food precursor, viosterol, yeast.
337. Vitamin F: cereal.
338. Vitamin G: cereal.
339. Vitamin potency: butter substitute, eggs, food, milk.
340. Vitreous porcelain: dinnerware, refrigerator.
341. Volatile: gasoline, coal.
342. Water softener: soap powder.
343. Watt: electric light, electric iron, machines, (ironing)
344. Wave length: food.
345. Weighting: silk, sheets, silk dresses, cotton.
346. Whiting: abrasive.
347. X-Ray: depilatory, drugs.
348. Zinc oxide: cosmetics, paint.
349. Zinc stearate: cosmetics.

The great bulwark of republican government is the cultivation of education . . . .—De Witt Clinton.

OUR SCIENCE ROOM

ARLENE V. FRITZ
Lexington School, No. 34, Rochester, New York

The natural science activities at Lexington School No. 34 are centered in one room. This room contains all the livestock and exhibits pertaining to the work in natural science which is carried on throughout the grades. Exhibits or pets may be borrowed at any time by any grade or the children may be brought directly to the room by their teacher. This room has become the most interesting room in the school.

The room has been built up gradually by contributions from the children, parents and friends as the work in natural science has progressed. We began with a few plants and two balanced aquaria, one containing gold fish, the other tropical fish. The tropical fish were among the very few things which were purchased by the school. In the early days of the room, we had an interesting experience in obtaining one contribution. One winter day, a canary was found back of the school. The bird was caught and taken into the science room where it was given food and water. A cage was borrowed and the bird seemed none the worse for its exposure to the cold. This was indeed a treat for the children. Their enthusiasm was soon quelled however, as the bird was claimed by a near by neighbor. A brief report was printed in the newspapers, expressing the disappointment of the children at the loss of their friend. Some interested readers sympathized with the children in their loss and not only one but three canaries as well as cages were presented to the school. As interest grew in this work, other things were rapidly added to our meager collection until now our thoughts are not on what we shall have in our room, but principally on where we shall put contributions and the care that should be given them.

The white rabbit which we have was born in our science room last May among a family of seven rabbits, the mother rabbit having been loaned to the school by the father of one of the children. Through this experience, the children were able to see how the rabbit makes her nest and how she provides for the young. This experience was of great value to the children.

We have a pair of white rats which gave birth to seven babies on Christmas Day. Could anything be more interesting and educational than to observe the care and growth of young animal life?

In February, we expect to mate canaries, thus providing another new and interesting activity.

A terrarium made by the children includes small snapping turtles, painted turtles, Mexican turtles, a toad, a frog and two salamanders. These will live with us all year, their home being made as near like their natural environment as possible.

A child attending the circus during the summer purchased a small chameleon. At home, a suitable cage was prepared for it to live in. The child cared for the pet all summer, watching it eat, change colors, and grow. In the fall, the chameleon in its

cage was presented to the science room much to the delight of everyone.

This room now contains many plants, bulbs planted by the children and a rock garden originally built by a fourth grade after a visit to the garden of a child in the grade.

Last year, the children were able to observe the development of the frog from the egg to the adult stage. They were also able to see the complete metamorphosis of the cecropia moth. The moths emerged in the spring, mated and then laid eggs from which the larva hatched. These were fed by the children and when full grown, spun cocoons.

During the spring and fall, many insects, water as well as land, are brought in. Homes are made for them so that the children can watch their peculiar traits. Some of the unusual ones are killed and mounted for permanent collection.

Among some of our other contributions is a beautiful specimen of the paper wasp's nest, together with a cross section showing the cells inside of the nest.

The room contains collections of moths, butterflies and other insects; birds' nests; shells and coral from southern waters; a collection of fossils, stones, different kinds of woods; and charts of various kinds. These have been provided by the children, some being brought in by individuals and others being contributed as a grade activity.

Perhaps you are wondering how all these things are cared for. The children, under the supervision of a member of the faculty, are responsible for the life and care of everything in the room. The plan which has been in use this year is as follows: Each grade is given complete charge of the room for two weeks. A committee of approximately ten children is selected from the grade in charge. These children have very definite responsibilities. For example, three girls take care of the canaries, two children clean and feed the white rats, two others care for the rabbit, the fish are fed by another child, someone else waters the plants and so on until everything has been attended to. All of these duties are carried on the first thing every morning, usually being completed before the final bell. Each grade in charge furnishes the food for the animals, definite menus having been decided upon previously. When the children in the Kindergarten, First and Second Grades are in charge of the science room, they are placed under the supervision of selected children from the upper grades who work with the younger children.

During the summer the pets and plants are taken home by the children until fall. Other living things such as snakes, turtles, frogs, etc. are returned to their natural environment.

The outcomes of a room such as this are probably immeasureable. Some that are evident are an improvement in English as each child who makes a contribution writes a little account of how it was found and just what the particular specimen is. These accounts vary from very simple ones such as "I found this snake under a rock." to "These are butternuts which squirrels have been eating. Notice the peculiar way the squirrels eat the nuts. I found them on a friend's estate." and "How

Peanuts Grow"—"If I were to plant some peanuts, I would take a raw peanut and plant it in sandy soil. In a few weeks, the peanut plant will grow. Most people think that peanuts grow like potatoes because they grow in the ground. The plant itself grows flat on the ground. The peanuts are not good until they are roasted. These particular peanuts were grown in the town of Greece."

Incidental reading lessons are composed by the lower grades after a visit to the science room.

Besides the knowledge of natural science and giving the children an interest for leisure time, we are also teaching indirectly laws of citizenship such as cooperation, dependability, cleanliness and correct attitudes toward life.

ELEMENTARY SCIENCE TEACHERS OF IOWA MEET

The Elementary Science Section of the Iowa State Teachers Association held their program and exhibits in the Science Rooms in the Administration Building at Drake University, Des Moines, Iowa, November 4, 1933.

The program consisted of the following papers:

"An Integrated Science Program in the Public Schools" by J. H. Jensen, head of the Science Department, Northern Normal and Industrial School, Aberdeen, South Dakota.

"Problems in a Superintendent's Mind Concerning Elementary Science Work in his Schools," by B. C. Berg, Supt. of Schools at Newton, Iowa.

An exhibit of pupils activities in Science from grades 1 to 6 of School systems in Iowa was on display in the Science Rooms. The exhibit of Science units was very representative of work from each of the six grades, and of different school systems.

One hundred and fifteen books for pupils and teachers in the following fields were on display:

(1) fur bearing animals.
(2) astronomy.
(3) miscellaneous list of books in science for pupils in grades 1–6.

Visual materials for teaching Elementary Science was also exhibited, such as lanterns, lantern slides, 16 mm. movie machines with science films, sources of birds, trees, wild flowers, pictures, charts, etc.

The officers of the organization were: Miss Lillian Hethershaw of Drake University, President, and Miss Romaine Startzer of Newton, Iowa, Secretary-Treasurer.

Over one hundred from the state visited the exhibits, seventy-five were in attendance at the program, also about two hundred teachers taking science in the College of Education visited the exhibit.

The section was formed in November 1931. This was the first state program and the first state exhibit of Science.

Perhaps the best way we can help the world today is simply by thinking. It is vastly easier to fight than to think, yet all fighting without thinking is sure to end in defeat. It is much easier to work than to think, but the harder a man works without thought the more damage he does.—W. H. P. FAUNCE.

THE RADICAL DREAM

A Playlet for Puppets

By J. M. Leps, *Arcadia, Florida*

ACT I, SCENE I

The curtain rises to discover a young lady lying fast asleep under a gnarled old oak, albeit of exotic design. At her side she has several books bound with a strap. Her sleep is slightly troubled. A rail fence meanders across the stage just back of the tree and gives the effect of a highway with a pastoral background of Euclidian design. Near the left side of the stage is a bridge which apparently crosses a stream.

A sound is heard off stage and a tall, gangling youth enters from the left and strolls up the road toward the center, whistling a melancholy tune. He sees the sleeping figure and stops.

Four. What's your function?

Polly. (Arousing from her slumbers and rubbing her eyes, answers) I don't believe I know you! (Her eyes say, "You impertinent thing.")

Four. Not know me? I'm one of the numbers—see (holding up fingers) One, two, three—me. I've been here from the first but not always quite so simple.

Polly. I should hope not. I never saw such a simpleton!

Four. (Looks hurt and begins to sob. Soon he is singing through his sobs very pathetically.)

Four and twenty blackbirds were baked in a pie,
And when the pie was opened the birds began to sing:
But Four was baked to blisters and couldn't sing a thing!

Polly. Oh, is that why you weep? (Relieved)

Four. Oh, no, no! But I must soon cross the bridge and become minus.

Polly. I do not see why that should be so bad.

Four. How could you when you are imaginary and irrational at that?

Polly. I am not irrational—I am not! . . . I think you are horrid—perfectly horrid! I . . . I . . . (Sobbing)

Four. I am positive—I have always been quite positive—and figures do not lie—They never lie—. Besides, if you're not irrational why do you have that radical sign over your head?

Polly. That's only my parasol. (Indignantly)

Four. Parasol indeed! Look in your vanity or look away from your vanity for once, and see if it is a parasol. (Polly does and is dismayed at what she sees.) *That* is the radical sign. All irrationals are marked by it.

POLLY. Oh, I will not have that ugly thing over my head. Take it off . . . take it off, please.

FOUR. It will not come off until you have been squared.

POLLY. Squared! You speak as though I were a criminal.

FOUR. Why, no—(Soothingly). There used to be one in our family. She was the square root of two but was squared with the rest of the equation and now is a factor of four. She is my mathematical half. She *thinks* she is my better half. I will introduce you to two, too.

POLLY. Why, that sounds like a whistle. (The Four again in mournful tones begins to sing.)

Sing a song of single men
With money in the bank.
I used to be a single man
But then I was a crank.

Sing a song of marriage ties,
Oh, Two, the filthy crook,
Divided through my happiness,
And left me quite forsook.

Sing a song of grief again
This life ain't half so funny
Wifie, Dear, gets liberty
While I pay alimony . . .

POLLY. (Timidly) I think that is a very clever song. I should like to hear more of it—But how does one get squared? I am sure I do not want to be irrational any longer.

FOUR. All that in due time, my dear—Some day your equal factor will come along riding a white charger or driving a four cycle Ford. You will know him for your mate and if you are wise—together you may escape the radical sign and perhaps enter the land of two dimensions.

POLLY. How will I know him?

FOUR. I can not tell you any more. The only one who can help you any further is Old Man Involution. If you go to the Power House and see him he might help you.

POLLY. I must find Mr. Involution. How do I find him?

FOUR. You couldn't possibly. You're only an imaginary and could not find anything. You are not even a creature of the first dimension.

POLLY. (Weeping all over again. At this juncture four new characters enter from the left and approach the pair who have been conversing under the tree.) Oh, who're they? (Whispers as she retires behind four.)

FOUR. They are the four fundamental operations—They govern the realm of mathematics. One of them may take you to the Power House.

The dignitaries had come abreast of the pair on the stage by now. They make a motley group. Count Subtraction is short and wide. He has a quick, graceful way of moving. His fingers have the nimbleness of a prestidigitator. Count Addition is a jolly, fat, fellow—round and hearty with a rhythmic laugh. Count Multiplication is a huge man, ponderous but swift in movement with a booming voice. He has long legs, a straight mouth, and casts a shadow like a pair of engineer's dividers.

COUNT SUBTRACTION. Well, Four, it's time you were transposed.

FOUR. Not yet—*Please* not yet—I am not ready to be transposed. Operations generally leave one minus and I don't want to be minus. (Tearfully)

COUNT SUBTRACTION. Come! What nonsense! There are no two times to do things. That would not be logical and things are never done illogically in our realm.

COUNT MULTIPLICATION. Well, let us be off. There is much we must do today.

POLLY. Oh, please—May I go along? I do want to be rid of this irrational, I mean radical sign. (Breathlessly)

COUNT MULTIPLICATION. But, my dear, I am afraid your mind is not sufficiently developed to travel in the realm of pure reason. You must be patient and when all the premises have been set forth and approved we will consider the solution of your problem. I will make a note of it.

POLLY. Oh, thank you so much. I hope it will not be long before I may go with you to the Power House.

COUNT MULTIPLICATION. Well, good-bye, my dear, you must get your tables by heart.

COUNT ADDITION. And do not forget your combinations. (Waving)

Multiplication and Division move off toward the bridge and are soon followed by Addition and Subtraction. Four goes along reluctantly between them. Polly waves until they reach the bridge. In the meanwhile Multiplication and Division have gone off the stage on the right.

COUNT ADDITION. We cannot keep up with those fellows

you know. We must always travel at a uniform rate while they travel with a uniform acceleration. You see their speed varies as the time squared. Do you see?

FOUR. Oh, yes I see. (With an air of not seeing at all)

On the middle of the bridge a little figure raises a window and says:

Check, please.

The Lord of Mathematics doth
On us this rule impose:
You always change your sign, sir
Before you can transpose!

COUNT SUBTRACTION. The two sides of our country must always balance so we keep account by signs.

He snaps a plus sign off Four's coat and receives in return for it a minus sign from the gate keeper which he places on the Four—The three proceed to the left talking ad lib—.

In the meanwhile Polly has wandered to the right a little way and back toward the bridge, apparently more interested in her own thoughts than in the country about her. Finally she seats herself at the foot of the tree and soliloquizes.

POLLY. I should be going home now because supper will soon be ready and I musn't keep Daddy and Mama waiting. I must dress because Bob is coming around tonight. I would like to go to the theatre and see Clark Gables' new picture. He's grand! I could love a man like that. . . . But Bob's cute, too—I suppose Mama'll make us stay home and get our lessons.

A frightful creature with a black envelope and a revolver appears from behind the tree and shouts in a hoarse voice:

BANDIT. Hands up! Your money or your life.

POLLY. I have no money, sir. (sobbing) Who are you?

BANDIT. I am X, the Unknown, the Al Capone of all the rackets in this realm of Mathematics. Those who do not pay I put on the spot.

There is a clattering off stage to the right and a figure on a white charger rides in bearing a long pencil as a lance. He lowers his pencil at the bandit and shouts.

HERO. Aha! X, you are equal to zero. (Strange to relate the robber resolves from sight behind the oak.)

POLLY. Oh, brave Sir! You have saved my life!

HERO. Oh, tut, tut, tut, 'twas nothing—I just completed the square and when I took the square root of both sides the solution was zero.

POLLY. Oh, I think you're wonderful!

HERO. I think you're very pretty, too.

There is a moment of embarrassment while Polly tucks her head and scratches designs in the sand with her toe. The Hero persuades his horse to cavort in a very thoroughbred manner.

POLLY. What a beautiful horse you have.

HERO. Thank you, I call him Calculator. Would you like to ride him?

POLLY. I'd love to . . . sometime . . . I have to go . . . now!

HERO. When may I see you again?

POLLY. I come this way most every day—Sir Knight!

HERO. Good-bye, fair Lady, until another day.

POLLY. Tell me who saved me from the wretched robber's plot.

HERO. I'm just the answer. Bless the chance that brought me to this spot.

He wheels about and rides off the stage. Polly waves and watches until he is out of sight.

Curtain

ACT II, SCENE I

Curtain rises on same scene with one exception. The curve of an equation appears against the Euclidian background. Its highest point is near the right of the stage and its lower point is a little left of the center. At the highest point of the curve sits Max E. Mum. At the lowest point sits Min E. Mum. Max looks at Min and waves his hand.

MAX. Hell-o, Min.

MIN. Hi, Max, come down.

Max slides down the curve to Min and they both sing.

MAX AND MIN:

Max and Min
Sat down to spin
A root for baby function,
But baby grew
A series too
Which showed a lot of gumption!

MIN. Do you know another verse?

MAX. No, but I know another song.

(They sing.)

When love begins to integrate—
The lives of boys and girls
They fail to differentiate
The problems of this world's.

Then love is at the Maximum
And none consider cash
Thinking's at a Minimum
While everyone acts rash.

A noise is heard off the left and Polly and the Hero enter hand in hand, but not before Max and Min have retired to their original stations.

POLLY. Don't you think it was fate or something the way we met?

HERO. I think it was the most wonderful thing that ever happened.

POLLY. Do you believe in love at first sight?

HERO. I didn't until I saw that old bandit pointing his gun at you.

POLLY. Oh . . . (Long pause) Have you ever been to the Power House?

HERO. Why, yes, I was there once with my father when I was a small fellow.

POLLY. What was it like?

HERO. Oh, it was very interesting. There was a vast room filled with desks and busy figures. The clerks were all working at their desks or at calculating machines. Messengers hurried here and there with books and papers. At opposite sides were the offices of Dr. Involution and Dr. Evolution. All around were alcoves. In some, clerks were using verniers, calipers, slide rules and other calculating devices. In some, books were stored. In one, artisans were making radicals of different sizes, while assistants were attaching indices. Several contained cabinets in which were rows and rows of orderly decimals. A large alcove was marked "The Orphanage," and from within came the sound of dry sobs.

POLLY. What was the matter?

HERO. The numbers whose logarithms could not be found were in there. It was sad but the Board of Calculators will find homes for them in due time.

POLLY. How very prompt to find homes for them in due time. Most boards never do anything in due time. In fact it is always too late when they do anything.

HERO. And then there is the Hall where the radicals in love are joined together in perfect squares.

POLLY. I thought they were joined together with a ring!

HERO. That is just another illogical and inaccurate idea. Have you ever noticed the shape of a boxing ring?

POLLY. Oh, my Knight . . . wouldn't it be cute if we . . . I mean wouldn't it be right . . . (tucks head with eyes downcast).

HERO. (The light dawns) You wonderful, wonderful figure. Do you really mean it?

POLLY. (As they fall into the time tested and immemorial routine for such occasions) This is so sudden!

Curtain

SCENE II

An imposing entrance to a walled enclosure is shown on the left side of the stage. Behind the walls is indicated the presence of a large building. Above the gate way appears the title "The Power House." On the left of the wall there is a parked area. A guard with a huge curved scimitar and a scarlet uniform paces back and forth before the gate.

Polly and the Hero enter from the left hand in hand. Polly seems a little reluctant or undecided about something. They pause beneath a tree.

HERO. Come, let us go and get our license.

POLLY. My darling, I'm frightened. Do you really love me?

HERO. Of course, you know I adore you. I adore you . . . I have since the first time I saw you near the bridge. And every day I've seen you since I've grown to love you more.

POLLY. And you don't think I am a bold girl to have fallen in love with you so easily?

HERO. Of course not, Silly, I think you are the most desirable girl in the whole world.

POLLY. Don't you think we should wait for a little? Everything is so strange.

HERO. But, my Darling, our arrangements are all made. Dr. Involution will be waiting for us.

POLLY. My dear, he frightens me so.

HERO. He is really very pleasant and besides our friends are all waiting for us. Miss Quadratic Surd is to be your maid of honor. Prime Factor is to be the best man.

POLLY. And Old Man Synthetic Division will give me away.

HERO. We will motor to the land of Polar Coördinates for our honeymoon.

POLLY. Is it cold there?

HERO. Oh, no. Very little of it, really, is cold. There are many famous highways there. We will take an old one called the Spiral of Archimedes, after a very learned man of Syracuse. The country side is very beautiful. Many famous engineers have worked there plotting points and constructing curves. We shall be so happy. Our love will be a geometric progression diverging into infinity. We will not take a discontinuous curve as so many unfortunates do.

POLLY. I do love you so. You are so good to me. I seem so undecided. Sometimes I wonder if I am really Polly after all. There are times when I think I am only an imaginary dreaming I am Polly. Then again I think I'm really Polly dreaming I'm imaginary. What a fix to be in! I don't know whether I am a real person dreaming I am a dream or a dream dreaming I am real. But I love you so much I think I will go with you. Then if I am really Polly everything will be fine and if I am an imaginary no one will ever know that all this has happened. How could anyone know what happens to an imaginary? There, I call that very square logic indeed. I am sure I can not be entirely irrational. At any rate I shall be rid of this radical sign, don't you think?

HERO. Why, of course, you will, Darling. I think you are a very smart person to understand there are two sides to everything. Only ignorant people are sure about things. The wise man knows it is hard to distinguish the good from the evil. What is good for one is bad for another. Time may still further alter conditions because nothing can be judged with any degree of accuracy unless time is considered as one of the factors. It has been said that the objective emanates from the subjective. The subjective follows the objective. When one is born the other dies. One is positive and then negative. Which is the better state? One does not know but, when one can comprehend the center, the origin at which all infinities converge, the positive and negative alike become one. Joy is so much like pain, and pleasure holds so much of grief that one finds it hard to tell which is which, if there is any difference. It takes a great deal of knowledge to understand the incomprehensibility of all things. But it does not take much thought to understand that we are complements one of the other and that nothing should ever separate us again.

POLLY. How astute you have grown! I'll tell you a secret. I really couldn't exist any longer without you.

HERO. You Darling! I have the dearest little home for us at (1,1) ready for your orders when we return. I have persuaded our old family factotum, the Function of One to be our butler and Common Fraction to cook for us. I hope you will love it. Come. Let us go now.

They approach and Cancellation, the guard, brings his sword to port.

CANCELLATION. "Who goes there?"

HERO. It is I.

POLLY. And I.

CANCELLATION. Oh, the imaginary units. Not quite so loud. It is not a capital I, you know.

HERO. We wish to see Dr. Involution.

CANCELLATION. Advance then and give the sine and cosine.

HERO.

In any triangle as ABC
Where C is an angle of 90 degrees;
The sine of A is a over c—
The cosine of A is the sine of B.
For either is written b over c.

CANCELLATION (lowering his sword and standing aside). Enter.

When the young couple have passed through the door Cancellation resumes his post.

Curtain

EPILOGUE

The curtain rises again on the scene of the first act. The daylight is beginning to face, and the atmosphere is not quite so geometric as before. Polly is lying in the same position and seems to be asleep again but now there is a smile on her face. A tall man with a brief case and an umbrella enters from the right and stops before Polly.

THE PROFESSOR: Why, hello, there. Haven't you been home yet?

POLLY (waking, rises and rubs her eyes). I have corrected your paper, Polly, and you got the answer. That's fine.

POLLY. Oh, yes, I got the answer.

Curtain

The schools, representing the common people, resent the attempt to make free public education in America like a charity handed down from the bounty of the rich.—WM. J. BOGAN.

LIQUID AMMONIA AS A SOLVENT AND REACTION MEDIUM

By Henry Wolthorn

Graduate Assistant, Ohio State University, Columbus

The recent awarding of the Willard Gibbs Medal to Dr. Edward Curtis Franklin, professor emeritus of organic chemistry in Leland Stanford University, called attention to a branch of chemistry which embodies the largest, single contribution of American chemists to chemical theory. For the study of reactions in liquid ammonia and the development of an ammonia system of compounds have been carried out almost exclusively in American laboratories. In these papers we wish to give a brief outline of that work.

Water has always held a unique position in chemistry, chiefly because it comes nearest to being a universal solvent. Also, most crystals owe their structure to the combination of one or more molecules of water with the molecule of the pure substance. Water is used as a standard in the determination of most physical constants. And as long as Lavoisier's theory of acids, bases, and salts was in vogue, water was looked on as the parent substance of these three classes of compounds. That is, if one hydrogen in water was replaced by a metal, the resulting compound was a base, such as KOH. If one hydrogen was replaced by a nonmetal, an acid was obtained, for example, HOCl. And if one hydrogen was replaced by a metal and the other by a nonmetal, a salt was formed, such as KOCl. In fact, inorganic chemistry might almost be called the chemistry of water.

What peculiar physical properties does water have which obtain for it this unique position? Next to solvent capacity, the most important one is its power to dissociate electrolytes dissolved in it, that is, its high dielectric constant. Its critical temperature, critical pressure, and boiling point are remarkably high, while its molar freezing point and boiling point constants are extremely low.

A determination of these same constants for liquid ammonia revealed that in physical properties this substance was very similar to water. While the constants were not as extreme as those of water, they were more so than for any other solvent. A comparison of the properties of ammonia and water is made in the following table:

	Ammonia	Water
Melting point	−77°.7	0°
Boiling point (760 mm.)	−33°.35	100°
Specific heat	1.13	1.0
Specific gravity at 20	0.607	0.9982
Critical temperature	131°	365°
Critical pressure	112 atmos.	195 atmos.
Dielectric constant	22 at −34°C	81.7 at 16°C
Molal freezing point constant	0.98	1.858
Molal boiling point constant	0.34	0.52
Heat of vaporization (normal b.p.)	337 cal.	536 cal.
Heat of fusion	108 cal.	79.5 cal.
Specific conductivity	5×10^{-11} at −33°	4×10^{-8} at 18°

A consideration of these facts suggested to Dr. Franklin that ammonia might serve as a solvent, reaction medium, and as a parent substance for a system of compounds, similar to the water or oxygen system. Subsequent research has shown this to be actually the case.

A large number of salts are soluble in ammonia, but not as many as in water. The nitrates, chlorides, bromides, and iodides are generally quite soluble, while the oxides, fluorides, carbonates, sulfides, and sulfates are insoluble. The difference in behavior of salts with water and ammonia is often very interesting. Silver chloride is fairly soluble in ammonia, silver bromide is more so, and silver iodide is very soluble. The relative solubilities in water are in the reverse order. Ammonium sulfide and arsenic sulfide are soluble, as are the cyanides, cyanates, and especially the thiocyanates. Sodium chloride separates from ammonia in long needles, with five molecules of ammonia of crystallization. Barium nitrate and silver nitrate are very soluble, and also crystallize out with several molecules of ammonia. Many chlorides form insoluble complexes, especially those of barium, magnesium, calcium, zinc, cadmium, manganese, cobalt, nickel, and lead. Red mercuric iodide dissolves readily in ammonia giving a colorless solution. On evaporating, clear, colorless crystals of $HgI_2 \cdot 2NH_3$ separate. When these are exposed to air, they effloresce, and red mercuric iodide remains.

One of the most remarkable things about liquid ammonia is its ability to dissolve metals. The alkali metals are very soluble, while the alkaline earth metals are fairly soluble. Even aluminum dissolves to some extent. Concentrated solutions of these metals are bronze in color and have a metallic luster. More dilute solutions are a very deep blue. While these solutions have

been known for nearly a hundred years, their true nature was not established until the beginning of the present century.

As a solvent for organic substances, ammonia is superior to water. Paraffin hydrocarbons are fairly soluble, while aromatic hydrocarbons are very soluble. Halogen derivatives are all soluble. Alcohols, ethers, and polyhydroxy alcohols are all completely miscible, aldehydes somewhat less so. Phenols are extremely soluble. Dyes are generally more soluble in ammonia than in water. Sugars are also soluble. In general, it may be said that most organic substances are fairly soluble in ammonia.

As with water, solutions of electrolytes in ammonia conduct the electric current readily, the conductivities being essentially similar to those of aqueous solutions. The equivalent conductance of concentrated solutions is less than the corresponding conductance in water, showing that the actual dissociation is less than in the latter medium. The equivalent conductance reaches a maximum at infinite dilution, but this value is greater than the corresponding conductance in water. This is due to the smaller viscosity of ammonia, resulting in a greater mobility of the ions. Ammonia solutions of strong electrolytes conform more nearly to the mass action law at low concentrations than do similar aqueous solutions.

As a reaction medium, ammonia is similar to water in some respects, and different in others. Neutralizations may be carried out in ammonia and the end-points determined by suitable indicators. Phenolphthalein is purple in alkaline ammonia solution, and colorless in an acid solution. Triphenylmethane is also a good indicator in ammonia, being colorless in acid, and red in alkaline solution. Hydrazobenzene is dark brown in basic, and yellow in acidic solutions. The most common inorganic substances which act as acids in ammonia are the ammonium salts. It has been shown that it is not the hydrogen ion in aqueous solutions which give them acidic properties, but rather the hydronium ion, $OH_3^+(H^+ \cdot H_2O)$. So it is to be expected that the ammonium ion, $NH_4^+(H^+ \cdot NH_3)$ will have acidic properties in an ammonia solution.

Since water dissociates to some extent into hydrogen and hydroxyl ions, many compounds cannot exist in contact with water due to the resulting formation of insoluble hydroxides. Ferrous cyanide, for instance, immediately gives a precipitate of ferrous hydroxide with water. Ammonia also dissociates to some extent, giving hydrogen and amide ions:

$$NH_3 = H^+ + NH_2^-$$

But reference to the value for the specific conductivities of water and ammonia given in the table show that the ion concentration in the former is about a thousand times as great as in ammonia. So that many substances which would hydrolyze in water, do not "ammonolyze" in ammonia, and can be prepared in that solvent. Some of these are ferrous cyanide, magnesium cyanide, zinc cyanide, stannous cyanide, ferrous thiocyanate, and aluminum cyanide. The last named is prepared by this reaction:

$$2Al + 3Hg(CN)_2 = 3Hg + 2Al(CN)_3$$

However, the impression must not be given that solvolysis does not take place in ammonia. Many salts, particularly some of the alkali ammonometallates which we will discuss later, are ammonolyzed to an appreciable extent.

Besides neutralization and ammonolysis, many other types of reactions take place in liquid ammonia. Barium chloride is less soluble than silver chloride in ammonia, so the following reaction takes place when barium nitrate is added to a solution of silver chloride:

$$2AgCl + Ba(NO_3)_2 = BaCl_2 + 2AgNO_3$$

Ammonium sulfide may be used in ammonia to precipitate the insoluble metallic sulfides just as in water.

The research work on reactions in liquid ammonia has been of especial importance in the study of reduction reactions, and in offering a general method of preparation for inter-metallic compounds and metallo-organic compounds. When the alkali metals dissolve in ammonia, they dissociate to give the usual metal ion and a free electron:

$$Na = Na^+ + e^-$$

Since in reduction reactions a transfer of electrons is involved, they take place with great facility in such solutions. In fact, reductions by solutions of metals in liquid ammonia offer the only means of studying reductions in a homogeneous phase.

When a salt is added to one of these metal solutions, a substance is often precipitated containing only the two metals involved. This furnishes a general method for preparing a large number of these so-called "inter-metallic" compounds:

$$4Zn(CN)_2 + 9Na = NaZn_4 + 8NaCN$$

A few of the compounds which have been prepared by this method are: Na_3Tl_2, Na_4Sn, NaCd, NaHg, $NaHg_2$, Na_2Hg_2, CaAg, Ca_7Zn, Ca_3Hg_2, and Ca_2Pb_3.

A considerable amount of research has recently been done, and is being done, on a class of substances which are on the borderline between inorganic and organic chemistry. They are known as metallo-organic compounds, and cannot be prepared in aqueous solution. For this reason, one of two methods is generally employed in preparing them: the Grignard method, or the liquid ammonia method. The latter is much more rapid and also more economical. Tetramethyl tin may be prepared by treating sodium stannide with methyl chloride in ammonia, using zinc as a catalyst:

$$4NaSn + 4CH_3Cl = (CH_3)_4Sn + 4NaCl + 3Sn$$

Tetramethyl tin is a liquid and may be separated by distillation. If it is treated with stannic chloride, trimethyl tin chloride is formed:

$$3(CH_3)_4Sn + SnCl_4 = 4(CH_3)_3SnCl$$

If this is treated with an ammonia solution of sodium, trimethyl tin is first formed:

$$(CH_3)_3SnCl + Na = (CH_3)_3Sn + NaCl$$

If an excess of sodium is present, sodium trimethyl tin is formed:

$$(CH_3)_3Sn + Na = (CH_3)_3SnNa$$

It is also possible to prepare $(CH_3)_2SnNa_2$ and $(CH_3)_2SnCl_2$. If these two compounds react in ammonia, substances analogous to ethane, propane, butane, etc. can be built up:

$$NaSn(CH_3)_2Na + Cl(CH_3)_2SnCl + NaSn(CH_3)_2Na = NaSn(CH_3)_2 \cdot Sn(CH_3)_2 \cdot Sn(CH_3)_2Na + 2NaCl$$

$$NaSn(CH_3)_2 \cdot Sn(CH_3)_2 \cdot Sn(CH_3)_2Na + 2CH_3I = (CH_3)_3Sn \cdot Sn(CH_3)_2 \cdot Sn(CH_3)_3 + 2NaI$$

While equations have been given only for the preparation of tin compounds, analogous substances have been prepared for silicon and germanium, and to some extent with boron and gallium.

In this paper we have shown the similarity of water and ammonia as solvents and reaction media, and also the value of liquid ammonia research as shown by the study of many compounds impossible to prepare in the presence of water.

IMPROVEMENT SHEET FOR PLANE GEOMETRY

By Carl G. F. Franzén
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The same general principles governing the use and application of the Improvement Sheet in Algebra, which appeared in the December issue of this journal, apply to this Improvement Sheet for Plane Geometry.

Aims

1. To develop an appreciation of fundamental spatial relationships.
2. To increase familiarity with geometric forms common to nature, art, and industry.
3. To inculcate ideals of precision of thought and statement in geometric proof.
4. To put new meaning into arithmetic and algebra and lay a foundation for further work in mathematics and other sciences.
5. To recognize the logical sequence of relationships which exist in geometry and allied subjects.

Teacher Activity

	Yes	*No*
A. Mechanical Aspects:		
1. Does the teacher have in readiness	____	____
a. The blackboard?	____	____
b. Compasses?	____	____
c. Rulers?	____	____
d. Chalk?	____	____
B. Treatment of Proof:		
1. Does the teacher try to eliminate memory work in demonstrations by		
a. Using different lettering from that used in the text?	____	____
b. Varying the arrangement or position of the figure?	____	____
2. Is a minimum amount of time given to theorems?	____	____
3. Is a maximum amount of time given to original exercises and numerical problems?	____	____
4. Is a minimum amount of time devoted to superposition?	____	____
5. Is a minimum amount of time devoted to indirect proof?	____	____
6. Is there a variety of proofs developed for an exercise due to a variety in methods of attack?	____	____
7. Are the pupils required to master the fundamental constructions?	____	____
8. Does the teacher give sufficient practice in the applications of formulas to numerical problems?	____	____
9. Does the teacher keep himself in the background during the demonstration?	____	____
10. Does the teacher require the pupils to give authority for all statements made?	____	____

	Yes	*No*
11. Does the teacher have placed on the board such problems as cause trouble to the majority in the class?	____	____
12. Does the teacher construct a sufficient number of original exercises to meet needs as they arise?	____	____
13. Does the teacher give frequent tests in order to check the work of the pupils?	____	____
14. Are unique and interesting historical facts about theorems presented to the class?	____	____
15. Does the teacher conduct memory drills on established facts concerning parallel lines, triangles, perpendicular lines, circles, etc.?	____	____
16. Does the teacher provide for individual differences by		
a. Maximum, minimum, and average assignments?	____	____
b. Giving starred exercises to the more capable pupils?	____	____
c. Requiring additional proofs of the more capable pupils?	____	____
d. Other supplementary work?	____	____
17. Does the teacher require the pupils to use a uniform plan for written work?	____	____
18. Does the teacher require the same standards in written work as in oral work?	____	____
C. Vocabulary:		
1. Does the teacher place emphasis on geometric terminology?	____	____
2. Does the teacher observe the spelling of geometric terms?	____	____
3. Does the teacher require correct pronunciation of geometric terms?	____	____
PUPIL ACTIVITY		
D. Mechanical Aspects:		
1. Do pupils have in readiness for written work		
a. Sharpened pencils?	____	____
b. Compasses?	____	____
c. Protractors?	____	____
d. Rulers?	____	____
2. Are figures accurately drawn?	____	____
3. Are the drawings those of general figures?	____	____
4. Are the drawings on the board visible to all members of the class?	____	____
5. Are upper case letters used to designate vertices?	____	____
6. Are lower case letters used to designate lines?	____	____
7. Is there consistency in the lettering of figures?	____	____
8. Is the lettering of figures different from that in the text?	____	____
9. Do construction lines show clearly?	____	____
10. Can auxiliary lines be distinguished from given lines?	____	____
11. Are the various parts of the figures, angles, lines, vertices, etc., clearly designated by proper symbols?	____	____

E. Treatment of proof:	*Yes*	*No*
1. Do pupils point to the figures on the board in making the demonstrations?	____	____
2. Do pupils demonstrate to the class rather than to the teacher?	____	____
3. Do pupils speak distinctly so that all may hear?	____	____
4. Do pupils clearly differentiate between hypothesis and conclusion?	____	____
5. Is the proof presented in logical order?	____	____
6. Do pupils give authority for statements made?	____	____
7. Do pupils make precise statements?	____	____
8. Are the reasons given in the proof abbreviated but intelligible statements of theorems, axioms, etc.?	____	____
9. Are the conclusions reached for a particular or given case immediately generalized for all cases?	____	____
10. Do pupils watch for weak points in each others arguments?	____	____
11. Do pupils coöperate in assisting the pupil who is giving the proof when he is in difficulty?	____	____
12. Do pupils discard erroneous statements quickly?	____	____
13. Do pupils suggest illustrations or every-day applications of the proofs or exercises in the lesson?	____	____
14. Do pupils use the geometric vocabulary intelligently?	____	____
15. Do pupils volunteer suggestions arrived at independently of the teacher or the textbook?	____	____
16. Are pupils at their seat busy while the board work is being prepared?	____	____

BIBLIOGRAPHY

Aim 2. *Mathematics Teacher*, 20: p. 177.

A. A- 1. Smith and Reeve, *Teaching of Junior High School Mathematics*, p. 148.

B. B- 1. Barber, Harry C., *Teaching of Junior High School Mathematics*, pp. 125–126.

a. Smith and Reeve, *Teaching of Junior High School Mathematics*, p. 267.

b. Smith and Reeve, *Teaching of Junior High School Mathematics*, p. 260.

B- 2. Young, J. W. A., *Teaching of Mathematics*, p. 264.

B- 4. Young, J. W. A., *Teaching of Mathematics*, pp. 282–283.

B- 5. Smith and Reeve, *Teaching of Junior High School Mathematics*, p. 259.

B- 6. Young, J. W. A., *Teaching of Mathematics*, p. 260.

B- 7. Morrison, Henry C., *The Practice of Teaching in the Secondary School*, p. 37.

B- 8. The National Council of Teachers of Mathematics, Third Year Book, pp. 51–56.

B- 9. *Mathematics Teacher*, 22: p. 335.

B-10. Smith and Reeve, *Teaching of Junior High School Mathematics*, p. 266.

B-12. Schultze, Arthur, *The Teaching of Mathematics in Secondary Schools*, pp. 104–105.
B-13. Breslich, Ernst R., *The Teaching of Mathematics in Secondary Schools*, 1930 Edition, pp. 147–170.
B-14. *Mathematics Teacher*, 23: pp. 1–7.
B-14. Schaaf, William L., *Mathematics for Junior High School Teachers*, pp. 56–57.
B-15. Breslich, Ernst R., *Teaching of Mathematics in Secondary Schools*, pp. 108–111.
B-16. *Mathematics Teacher*, 23: pp. 155–160.
B-17. Breslich, Ernst R., *Teaching of Mathematics in Secondary Schools*, p. 107.
C. C- 1. Young, J. W. A., *Teaching of Mathematics*, pp. 190–193.
D. D- 1. Breslich, Ernst R., *Teaching of Mathematics in Secondary Schools*, pp. 116–130.
D- 3. Smith and Reeve, *Teaching of Junior High School Mathematics*, p. 260.
D- 5–6. Barber, *Teaching of Junior High School Mathematics*, pp. 129–130.
E. E- 1. Smith and Reeve, *Teaching of Junior High School Mathematics*, p. 255.
E- 4. Smith and Reeve, *Teaching of Junior High School Mathematics*, p. 261.
E- 5. Young, J. W. A., *Teaching of Mathematics*, p. 126.
E- 7. Smith and Reeve, *Teaching of Junior High School Mathematics*, p. 267.
E- 8. Smith and Reeve, *Teaching of Junior High School Mathematics*, p. 266.
E-10. Breslich, Ernst R., *Teaching of Mathematics in Secondary Schools*, p. 100.
E-13. Smith and Reeve, *Teaching of Junior High School Mathematics*, p. 241.

ECONOMETRICA

Econometrica is the journal of the Econometric Society, an international society founded two years ago "for the advancement of economic theory in its relation to statistics and mathematics." It is published quarterly, Volume I, Number I being the January 1933 issue. The editor is Ragnar Frisch, Professor of Economics, University of Norway, Oslo; the associate editors are Alvin H. Hansen, Professor of Economics, University of Minnesota, Frederick C. Mills, Professor of Statistics, Columbia University, and Harold T. Davis, Associate Professor of Mathematics, Indiana University. William F. C. Nelson, Lecturer in Statistics, Colorado College, Colorado Springs, U. S. A. is assistant editor and Alfred Cowles 3rd of the same college is circulation manager. The advisory editorial board includes professors from nineteen of the leading universities of the world.

All interested in the study of econometrics should read the editorial in the first issue giving the purpose of the society and the scope of its official organ.

CINEMA IN THE CHICAGO PUBLIC SCHOOLS

By William J. Liska
Formerly Assistant Director of Visual Instruction, Chicago Public Schools

Two aims considered important by educators today are: (1) the direct improvement of teaching, and (2) the improvement of teachers in service. A survey of educational literature reveals a great number of devices to be used in accomplishing these aims. One of the methods that is receiving considerable impetus at present is the use of motion pictures as a means of vitalizing instruction. However, there seems to be a division of opinion as to the value of this procedure in the improvement of methods of presenting subject-matter. Hence, the object of this study is to determine the attitude of administrators and school principals toward the use of motion pictures in educational procedure.

For the past six years, the Visual Bureau of the Chicago Public Schools has maintained a film service and program which have been available to all schools. A considerable number of principals availed themselves of this service and thus gained a first-hand knowledge of the value of motion pictures in aiding instruction. It was decided to send a questionnaire to members of this group who had come in contact with educational films for the purpose of determining their reaction to the above procedure.

Four hundred questionnaires were sent to school principals, district superintendents, and assistant superintendents of schools for the purpose of determining their reactions to the use of educational films. Three hundred and twenty-two were returned. In replying to the questionnaire, some qualified their response while others contributed some very interesting comments. These are given below the tabulation for each question.

Because of the nature of the facts desired, the questionnaire took the form given below:

Tabulation of Results on Questionnaire

Number of questionnaires sent out	400
Number of questionnaires returned	322

Of those returned, three stated that they were unfriendly toward the use of the motion picture in educational fields.

QUESTION 1. *Do you approve of the motion pictures in school? (A) If so, why? (B) Comment.*

A. 1.	Yes	310
2.	No	3
3.	Qualified yes	9
B. 1.	For stimulating activity, skills, etc.	63
2.	For education and vocational guidance (factual)	98
3.	For correcting wrong impressions; presenting facts, objects or word symbols	28
4.	For providing a wide field of first hand information not otherwise available	147
5.	No—cannot compete with theatres	1
	Total	659*

Sampling of responses:

Motivates instruction
Is pictorial information and the majority of pupils are "eye minded"
Strong appeal
Develops comprehension
Illuminates meaning
Corrects wrong impressions
Powerful in character building
Makes clear complex processes and situations
Objective education
Visual image is a vivid, exact and lasting impression

QUESTION 2. *In what specific place can the film be used to best advantage?*

A.	General uses:	
1.	See answers to Question 1	40
2.	For remedial work	8
3.	For use in the kindergarten thru to college	19
4.	For the review of subjects	12
5.	For developing specific knowledge, understandings, and appreciation	30
6.	For creating opportunities of self expression (leadership)	20
7.	For developing initiative and the adjustment of individual differences	32
	Total	161
B.	Specific uses:	
1.	For lending itself to a particular subject in the curriculum	4
2.	For social studies	54
3.	For education and vocational guidance	32
4.	For science	6
5.	For developing latent ability of retarded pupils	3
	Total	159
		320*

* Some failed to answer, and others gave more than one reason.

Sampling of responses.
- Auxiliary to regular study
- Fits any subject
- Nature study and health programs
- Where objective information is desired
- Correlates visual experience with book experience
- New avenue of learning
- Using films and find them O.K.
- Direct method of acquiring information
- Breaks down the traditional four walls of a classroom
- Supplements work in social studies, literature, dramatics health and art.

QUESTION 3. *Upon what grounds would you justify the use of motion pictures in (A) classroom and (B) assembly?*

A. Classroom use:	
1. For vitalizing classroom subjects	140
2. For a more advantageous presentation when used in the classroom	50
3. For disciplinary value	30
Total	220
B. Assembly hall use:	
1. To balance teacher effects	10
2. To economize in time of instruction	70
3. To effect financial economy	10
4. To provide and stimulate social value objectives	66
5. To special appeals; i.e., holidays	10
Total	166
	386*

Sampling of responses:

A. Classroom use
- Time saver
- Good device—tested
- Motivates teaching
- Needs no defense—generally approved—know from experience
- Has no place—a waste of time

B. Assembly hall use
- Teaching large groups
- Citizenship and character training
- Entertainment that is legitimate
- Present whole units of work
- For vocational or educational guidance programs.

QUESTION 4. *What is the retentive value, if any, obtained from the use of motion pictures?*

1. I don't know (no criteria for judging)	60
2. Increase in social and apperceptive background	30
3. Knowledge received through visual images is recalled at will	20
4. Appreciation and enjoyment are factors	18
5. Marked finality of judgment	41

6. Retention depends upon the teacher's use of what the children have gained 101
7. Films have a greater effect than the textbook 46

Total 316*

Sampling of responses:

A. From the educational point of view—
Depends on teacher
Intensifies learning
Broadens concept
Gives concrete experience
Follow-up examinations show high percentage scores

B. From the administrative point of view
Provides recreation and entertainment that is supervised
Connects the Assembly hall with the rest of the school
Psychological factors of learning are involved
Facilitates testing program
Presents various methods of teacher techniques
Remedial work

QUESTION 5. *Do you feel that the use of motion pictures is a waste of time?*

1. No, not a waste of time 196
2. No, if common sense is used 40
3. No, it depends on subject matter 22
4. Film co-ordinates lesson technique 20
5. Films give experiences not obtainable by other means, i.e., textbooks included 31
6. Films are purely entertainment 15

Total 324*

Sampling of responses:

Not if wisely chosen and accurately portrayed
Not if followed by suitable check-up with classroom activity
They are yet, because they are not related to work in the schoolroom
Student expression is in participation of activity suggested by the film lesson
Make a lazy teacher lazier
More research work needed

QUESTION 6. *If teachers were trained in the technique of "Use and projection of Motion Picture Films," would you consider the use of same in school procedure?*

1. Yes 294
2. No. Training is not necessary 3
3. I want to teach my own teachers 6
4. Who is going to train them? 5
5. Good teachers do not need training: they adapt themselves 4

Total 312*

Sampling of responses:

Yes was repeated many times in the sampling
Good teacher does not need training
Favorable conditions are necessary
It is necessary to train the teachers to the technique of using visual material.

QUESTION 7. *Add any comments not solicited by the above questions.*
Over 150 typewritten pages were compiled from the responses and organized as follows:

A. Improvement:
1. In general policy of distribution of film
2. In accessibility of film materials
3. In worth-while films
4. In maintenance of films
5. In cutting of cost
6. In a well developed and functioning film library
7. In the functioning of the central office
8. In having a specialized field and a good system of delivery

B. Many examples of value and efficiency of the use of films were cited, and the following is one:
"I believe this story speaks for itself. A seventh grade average boy was sent to the office for discipline. He was instructed to think over the form of punishment he would suggest. It was time for 'Movies' in the assembly hall. 'Can't I go to the movies?' 'Do you think you ought to go?' 'I find it hard to recite history—when I see the pictures then sometimes I can make a recitation.' The boy was sincere; he went to the assembly hall. There should be a licensed operator provided by the central office."

C. Classification
Need better film service
Need films that can be used with school subjects
Need better production
Need educational films
Too many films are bad.

CONCLUSION

A careful examination of the data reveals that the majority of school administrators are in favor of using educational films. The effectiveness of a film lesson is recognized inasmuch as a film lesson does not depend on sight alone but upon its adaptability to provide material for thought and study. Although entertainment is provided content is not revealed by a glance, and the teacher is required to guide and direct student activity. The film stimulates thought-provoking questions, questions of interpretation of subject-matter, factual questions demanding recall, development of questions of cause and effect, along with practical and judgment questions.

Purposeful education, with all its objectives and aims, must provide an understanding for the participant. It is not ground to be measured, but the development of new attitudes and new powers. Hence, the motion picture adds a tool to education. With the proper film, and the proper use of motion pictures, education is made more effective, and the result more lasting. Recognizing that the primary purpose of all teaching is identification of real learning products, it follows that these units demand an operating technique. The motion picture film blends into the accepted modern educational theory and practice. The plan actually works and is not theoretical. The film gives an intimate relationship between instructional material and learning exercises; hence, it is vital in school procedure. It brings the life out-of-doors into the schoolroom. Statistics have shown that the cost of education is reduced with the use of motion picture films. As a device, the motion picture can contribute to (1) the direct improvement of teaching, and (2) the improvement of teachers in service.

FROM THE SCRAPBOOK OF A TEACHER OF SCIENCE

By Duane Roller
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"Obvious" is the most dangerous word in mathematics.—*E. T. Bell, American mathematician, in "The Queen of the Sciences."*

However it may be in engineering and the sciences, in mathematics the deliberate attempt to create something of immediate utility leads as a rule to shoddy work of only passing value. The important practical and scientific applications of mathematics are unsought byproducts of the main purposes of professional mathematicians.—*E. T. Bell, in "The Queen of the Sciences."*

Through many an ohm the weber flew,
And clicked the answer back to me,—
I am thy farad, staunch and true
Charged to a volt with love for thee.
—*James Clerk Maxwell, "Valentine from a Male Telegraphist to a Female Telegraphist."*

If judicious men, skilled in chymical affairs, shall agree to write clearly and plainly of them, and thereby keep men from being stunned, as it were, or imposed on by dark empty words, 'tis to be hoped that these men (the Alchemists) finding that they can no longer write impertinently and absurdly, without being laughed at for doing so, will be reduced either to write nothing, or books that may teach us something, and not rob men, as formerly, of invaluable time; and so ceasing to trouble the world with riddles or impertinencies, we shall either by their books receive an advantage, or by their silence escape an inconvenience.—*Robert Boyle, in "The Sceptical Chymist."*

VERBATIM REPORT OF A CLASS IN ARITHMETIC

By Joseph A. Nyberg
Hyde Park High School, Chicago

This is the third of a series of reports of what happens in a classroom. The previous reports, in the December, 1932, and January, 1933, issues, dealt with classes in plane geometry; the following one deals with a class in arithmetic in the seventh grade during the eleventh week of school. There were 42 pupils in the class. The letters *T* and *P* indicate that the teacher or some pupil is speaking; no attempt was made to differentiate between the pupils. Each letter *P* denotes a different pupil.

The class had assembled just after the lunch period. As soon as the room was quiet the teacher began.

* * *

T. How do you find the area of a rectangle?

P. To find the area of a rectangle you multiply the numbers of the length by the width equal squares.

T. How do you find the area of a square?

The three pupils who were called could not answer, and no pupil volunteered an answer.

T. How do you find the area of a square 6 in. on each side?

P. Multiply 6 in. by 6 in.

T. No! (Very emphatically).

P. Multiply 6 by 6 sq. in.

T. How many names can you multiply?

P. One.

T. Where does the name come?

P. At the right.

T. What do you call the length and width?

P. Dimensions.

T. What do you mean by dimensions?

One pupil said: Linear measure. Another said: Measurements. Another said: Measure of Dimensions. Finally the answer desired by the teacher was obtained: Dimensions are edges.

T. Now what are the dimensions of the square?

P. Length and width.

T. Then how do you find the area of a square?

P. Multiply the numbers of the length by the width.

T. Yes. You can find the area of a square just like a rectangle.

(5 minutes)

T. Now suppose you had a lot and wanted to sell part of it. (The teacher drew a rectangle on the board, drew a diagonal, and shaded one half of the rectangle.) What do you call this part that I have shaded? The answers were:

P. A three cornered square.

P. It has three corners.

P. Three straight lines. (To this answer the teacher drew 3 lines radiating from one point.)

T. Half of a rectangle is a triangle, but I want you to tell me what a triangle *is*. (With much emphasis on *is*.)

P. Three straight lines that come to a point.

P. Lines that are straight up and down from each other. (The teacher showed that this was wrong by drawing a right angle.)

P. A triangle is the difference where two lines meet at a point.

P. A triangle is half of a rectangle.

T. I know it is half a rectangle but what is it? A circle? Certainly not! What is it?

P. An angle.

P. Half a lot.

P. A polygon of 3 sides.

T. But what's a polygon then?

P. A dimension.

P. A three cornered angle.

P. It's a figure.

(13 minutes)

This answer satisfied the teacher. Everyone gave a sigh of relief. After a brief pause, the teacher began again.

T. What kind of a figure? What are its limitations?

P. Three lines meeting in 3 points.

P. A triangle is an angle.

P. A triangle looks like . . . .

T. I don't want to know what it *looks* like. I want to know what it *is*.

P. A figure with 3 lines.

P. The dictionary says . . . .

T. I don't want to hear what the dictionary says. Can't you tell yourself by looking at it?

P. Triangle is a figure bounded by 3 lines.

T. That's exactly the word I wanted: *bounded* by 3 lines. What is a rectangle bounded by?

P. Four lines.

T. What is a triangle bounded by?

P. Three lines.

T. What is an angle? Class?

The class recited in unison: Angle is the difference in direction of two lines which meet at a point.

T. What is a rectangle? Class?

The class recited in unison: Rectangle is a figure bounded by 4 straight lines that meet at four points. Some of the pupils added: meeting at right angles.

T. What is a triangle?

P. A figure bounded by 3 straight lines and 3 corners and equals so many squares. (When this pupil was called on all the other pupils turned to look at him, and seemed ready to laugh. He was evidently the dunce in the class and was not expected to give an intelligent answer. The teacher paid no attention to the answer, but turned to look for some papers on the desk.)

(18 minutes)

The teacher drew another rectangle on the board, drew a diagonal, and then pointing to the lower edge, said: Would you call this line the length of the triangle? What would you call it? Various pupils answered: height; width; base.

T. What do you build a house on?

P. Foundation.

The teacher folded a piece of paper into a triangular shape, and asked: What would we call this line (running a finger along the lower edge)?

P. The altitude.

P. The hypotenuse.

The teacher appeared disgusted with the answers, and said: *Base.* Then the teacher held the triangle so that the vertex was below the base, and said: Now it would fall over because it is not on a firm foundation, not on its base.

The class had now lost interest in the work, and the response from the pupils was very slow.

(25 minutes)

T. A triangle is one half of a rectangle.

The teacher then wrote on the board:

$$\text{Area} = \tfrac{1}{2} \text{ base} \times \text{alt.} = \text{squares.}$$

The teacher divided the rectangle into squares with a few horizontal and vertical lines. One pupil arose and said: Some of those squares along the base are not full squares. The teacher

answered: But the half squares can be put together and made into full squares.

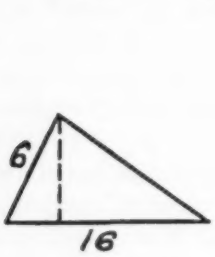
The teacher drew the first figure shown below, and wrote:

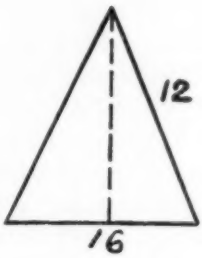
$$A = \tfrac{1}{2} \text{ base} \times ?$$

T. You can't find the area of this triangle because 6 is not the altitude. And you can't find the area of this triangle (drawing the second figure shown below) because the altitude is not known.

T. How do you measure altitudes?

P. On a straight line right across.





(35 minutes)

T. Now work this problem: What will it cost to buy a farm 80 rd. by 60 rd. at $50 an acre? Draw a figure for it.

The first pupil finished in one minute and showed his work to the teacher, who said: Wrong. During the first 3 minutes, 10 pupils had finished. One pupil was asked to write his work on the board. He wrote:

$$\text{Area} = 60 \times 80 \text{ sq. rd.} = 4800 \text{ sq. rd.}$$

160) 4800 sq. rd. (30 acres

480

$$\text{Cost} = 30 \times \$50 = \$1500$$

T. Work this problem: What will it cost to fence that farm at 5¢ a foot?

Within a minute 8 pupils were at the teacher's desk, and one of them was asked to write his work on the board. He wrote:

80 rd.	16½ ft.
60 rd.	280
80 rd.	140
60 rd.	128
280 rd.	32
	6620 ft.

Cost of fence = 6620 × 5¢ = $331.00

When the bell rang at the end of 45 minutes the teacher was examining the work of the pupils as they came to the desk.

On the following day all of the 45 minutes was devoted to an examination. The teacher wrote the following problems on the board:

1. What is a rectangle? A triangle? A dimension?
2. What will it cost to paint a floor 12 ft. by 18 ft. at 9¢ a sq. yd.?
3. How many acres in a rectangular field 64 rd. by 32 rd.?
4. What will it cost to fence the field in no. 3 at 7¢ a ft.?
5. How many sq. in. tiles in a hallway 8 ft. 5 in. by 9 ft.?
6. What is the area of a triangle whose altitude is 18 ft. and base 12 ft.?

* * *

The teacher of this class doubtless believes in the heuristic method. Instead of stating the definition of a triangle, the teacher aimed to draw from the pupils their own definition. The chances are good that if the teacher had merely asked the pupils to draw a triangle, almost all would have drawn one correctly. The pupils know what kind of a figure a triangle is. But they do not know the words needed to express their ideas—the word *bounded* for example. The heuristic method fails unless the pupils have the proper vocabulary for expressing their ideas.

The notion that you cannot multiply inches by inches or rods by dollars is rather prevalent among people who have not done much work in physics. The physicist multiplies feet by pounds with no hesitation. It is of course true that we never do multiply anything except numbers; but after the product has been obtained, we interpret the result by using the names of the factors.

The reader doubtless thinks that this teacher was an unusual one—that few teachers accomplish as little in 45 minutes as this teacher. However, this class was chosen as the one to be visited and recorded because the principal of the school stated that the work done in this class would be a model for other teachers.

The driving force that makes either war or peace is engendered where the young are taught. The teacher, whether mother, priest or schoolmaster, is the real maker of history; rulers, statesmen and soldiers do but work out the possibilities of co-operation or conflict the teacher creates. . . The politicians and the masses of our time dance on the wires of their early education.—SALVAGING OF CIVILIZATION.

A SELECTED AND ANNOTATED BIBLIOGRAPHY OF SECONDARY BIOLOGY

By Blondel Carleton
Berkeley, California

THE OBJECTIVES

"I am reminded of the Guides who, like good Biology teachers, must try to show the whole (Grand) Canyon to the Wayfarer who can tarry but a few days at the brink of the inexhaustible store of treasure."—Alfred C. Kinsey.

"The High School Biology Course teaches the underlying principles of living matter and is, therefore, fundamental to scientific knowledge of health."—Mary Elizabeth Lynch.

GENERAL PURPOSES

(1) "To gain a basis for the solving and understanding of human problems by studying the life processes of plants and animals.

(2) To learn to maintain physical and mental efficiency.

(3) To survey vocational opportunities from the standpoint of biology.

(4) To gain new interests for the enjoyment of leisure time.

(5) To understand the relationship between human beings and the rest of the living world."—Edna W. Bailey.

"The difficulty is that we set down long lists of things that we feel we should accomplish, and then file the lists away and forget about them. We make the lists long so that they will make a sufficiently impressive appearance. We file them away so that we can find them and exhibit them when someone asks what we are trying to do."

"It seems to me that we should try to get down to brass tacks on this matter of objectives. . . . Since, in order to make use of scientific knowledge we must teach it in the form of principles it most assuredly follows that every step in the teacher's method must be planned with that end in view."—Ernest E. Bayles, University of Kansas.

Bayles continues: "We find such titles as Seeds, Flowers, The Grasshopper, The Frog, Mammals, Flowering Plants. These terms are purely descriptive, and imply chapters which are descriptive, only. Science must do something more than merely describe. It must *organize* and *interpret*."

Bayles then gives eight examples of the *type* of objectives

that he believes are more valuable. It will be noticed that only this type was selected for the present compilation. The eight are:

(1) The nature of living things.
(2) How living things are adapted to their environment.
(3) How plants are adapted for the maintenance of food.
(4) How food is prepared for use in the bodies of living things.
(5) The conservation of our biologic wealth.
(6) Modification and improvement of plant and animal forms.
(7) How living things maintain their kind.
(8) How living things maintain their health.

It is apparent that Bayles' suggestions, as given, are more in the nature of units than objectives, but the idea which he advances—that objectives should be few and important, rather than many and forgotten, is worthy of considerable emphasis.

From Paul Nurnberger's work one objective was selected: "To acquaint the student with the elementary laws of nature necessary for the maintenance of his own and community's health."

These generalized objectives are valuable in providing a better perspective for a course which could easily be lost in details.

REFERENCES TO THE LITERATURE

Bailey, Edna W., A. D. Laton, and A. L. Turner. "Biology in Reorganization of High School Sciences." *University High School Journal: 4:* 122–130, and Ibid *4:* 35–45. (1924).

Bayles, Ernest E. "Major problems in the Teaching of Natural Science." *School Science and Mathematics: 31:* (9): 1048–1055. (1931).

Kinsey, Alfred C. "The Contents of the Biology Course." *School Science and Mathematics: 30:* (4): 374–384 (1930).

Lynch, Mary Elizabeth. "High School Biology as a Contributing Factor in Health Education." *School Science and Mathematics: 31:* (8): 931–951. (1931).

Nurnberger, Paul. "Objectives of Natural Sciences." (Concluded from December 1925) *School Science and Mathematics: 26:* 33–43. (1926).

Weber, Lynda. "The Use of the Unit-Contract System in Teaching Biology." *School Science and Mathematics: 28:* 399–413. (1928).

General

Bode, Boyd H. "Why Educational Objectives?" *Journal of Educational Research: 10:* (3) 175–186. (1924).

Counts, S. A. "Validation of Objectives." *Journal of Educational Research: 10:* (3) 197–207. (1924).

Conklin, E. G. "Biological Research and Education." *School and Society: 32:* 751. (1930). (Dr. Conklin believes the results of biological investi-

gation into the principles of evolution should find application in public schools.)

Bueker, E. D. "High School Biology." *School and Society. 33:* 861. (1931). (A stimulating article.)

THE PUPILS

It would be impossible to completely analyze, here, the present knowledge of the pupils in the tenth grade, where most of the secondary biology teaching is done. Rather it is the intention to give attention to the fact that there is a pupil viewpoint, and that as much attention must be given the needs and possibilities of the students as is given to the formal course itself—if, in fact, the course should not really be developed from what is known of these pupils. The material in this section is divided into several topics.

Pupil Interests, Activities, and Traits
Illustrative Articles, Books

Charters, W. W. "*Activity analysis* and curriculum construction." *Journal of Educational Research: 5:* 357–367. (Charters writes: "An activity analysis is the analysis of both the mental and physical activities which are carried on by the individual.")

Charters, W. W. "A Technique for Trait Analysis." *Journal of Educational Research: 10:* (2): 95–100. (1924).

Charters, W. W. "Functional Analysis as the Basis of Curricular Construction." *Journal of Educational Research: 10:* (3): 214–221. (1924).

Hollingworth, Leta S. "The Psychology of the Adolescent." D. Appleton. New York. 1928. (The author writes a warning of the limitations of pupils of this age: "Psychological and educational measurements show that the average adolescent has not that degree of intellectual power which is necessary, for instance, to master algebra.")

Whitley, M. T. "Children's Interest in Collecting." *Journal of Educational Psychology: 20:* (4) 249–261. (1929). ("A general interest existed in children between the ages of nine and thirteen years." The strongest interest in collecting noted from eight to eleven years of age.)

Tests and Measurements

Dickson, Virgil E. *Mental Tests and the Classroom Teacher.* Yonkers-On-Hudson, New York. 1923. World Book Company. 231 pages.

Kelley, Truman L. *Statistical Method.* New York. The Macmillan Company. 1923. 390 pages. (Reviewing it, Otis wrote: "We have waited long and patiently for this book, and now that we have it, there is no doubt left in our minds that Truman Lee Kelley is America's foremost Statistician.")

Monroe, W. S. "*The Theory of Educational Measurements.*" New York. Houghton Mifflin Company. Riverside Press. 1923. 364 pages.

Otis, Arthur S. "*Statistical Method in Educational Measurement.*" Yonkers-On-Hudson. New York. World Book Company. 1925. 337 pp.

Pressey, L. L. and L. C. *Introduction to the Use of Standard Tests.* New

York. The World Book Company. 1922. 263 pages. (This is an elementary text.)

Ruch, Giles M., and George D. Stoddard. *Tests and Measurements in High School Instruction.* New York. World Book Company.

Thorndike, E. L., et al. The Measurement of Intelligence. Columbia Univ. The Pupils.

NATIONALITY

Brown, Gilbert L. "Intelligence as Related to Nationality." *Journal of Educational Research: 5:* 324–327. (1922).

Jordan, Riverda H. "Nationality and School Progress." Bloomington. Public School Publishing Co. 1921. 105 pp. (The Italians, for instance, are usually retarded.)

Jordan, Riverda Harding. "An Accurate Index of Nationality." *Journal of Educational Research: 5:* 421–425. (1922).

Young, Kimball. "Mental Differences in Certain Immigrant Groups." Univ. of Oregon Publications. *1:* (11) July 1922. Eugene, Oregon (This study was conducted in regions of or near the Eastbay area of San Francisco Bay. It is detailed. It agrees in many points with the previous study by Jordan.)

EXCEPTIONAL PUPILS

Terman, Lewis M. "Mental and Physical Traits of a Thousand Gifted Children." Stanford University. California. Stanford University Press. 1925. 648 pages. (As Volume One of the Genetic Studies of Genius.)

Yates, Dorothy Hazeltine. "A Study of Some High-School Seniors of Superior Intelligence." Bloomington Public School Publishing Company. 1922. 75 pages.

Stedman, L. M. "Education of Gifted Children." Yonkers-on-Hudson. World Book Company. 1924. 190 pp.

THE SOCIAL NEEDS

"By no means the least of the functions of educational sociology is that of emphasizing education as a life process rather than as a narrow school process."—Walter Robinson Smith.

"The values of education in most of its varieties are realized, however, *both* by the individual and the societies in which he has or is to have responsible membership—that is, his family, his country, his city, his religious denomination and the rest." —David Snedden.

In other words, in formulating a given course two of the needs which must be served are those of the individual and those of society.

Specifically, biology and social considerations have an equally reciprocal relationship. Edna W. Bailey and others write, for instance: "*The whole tremendous task of feeding and clothing and sheltering humanity is fundamentally a world-wide, age-long, 'quiz' in biology.*"

M. F. Guyer, of Wisconsin, speaking as a professional biologist before the Wisconsin Schoolmasters' Club, said:

"A successful democracy can, in the last analysis, spring only from good blood. In brief it (democracy) is a biological problem. Evidence for the inheritance of mental and temperamental characteristics is obtained by calculation according to special standards, of likeness, between near relatives and by the study of certain family strains and the stocks from which individuals of superior capacity have sprung."

The University of California psychologists now have experimental evidence indicating to their own satisfaction an inheritance of mental ability and capacity in white rats. They do not seem to hold the older ideas of non-inheritance of such mental abilities.

E. G. Conklin has written many articles pointing out the direct application of certain biological principles to social organizations. Natural selection, evolution, the rise and fall of races, modification, inheritance, population questions,—all these and many more occur in living forms of all types including the human.

Just as the school is inseparably connected with society because the school itself is a society, so biology has a permanent bond with society because societies themselves are biological manifestations.

The Bibliography

Bailey, Edna W., A. D. Laton, A. L. Turner. *Biology in the Reorganization of High School Sciences.* University High School Journal: *4:* 122–130.

Smith, Walter Robinson. *Principles of Educational Sociology.* Cambridge, Mass. 1928. The Riverside Press. Houghton Mifflin and Company.

Snedden, David. *Educational Sociology for Beginners.* New York. The Macmillan Company. 1928.

THE GENERAL UNITS

"Objectives" provide the first, generalized, criterion for a course. It is becoming customary to embody subject matter in a few units of study. A few sets of such units is given to illustrate the way in which this is done. By the use of these units it has been possible to follow more concretely the general objectives—first of secondary education as laid down in the "Cardinal Principles"—and secondly those objectives defined by the committees on Reorganization of High School Sciences. Although a special section has been devoted to objectives, it is worth while

to arrange the present section from a two-fold viewpoint, first, integration with the objectives of secondary education—and secondly the necessary correlation with small details in subject content of a high school biology course.

Williams and Rice in their *Principles of Secondary Education* summarize the findings of the Reorganization Commission. The commission, according to their summary, takes "the position that 'secondary education should be determined by the needs of the society to be served, the character of the individuals to be educated, and the knowledge of educational theory and practices available.' " The seven objectives are "1. Health. 2. Command of fundamental processes. 3. Worthy home-membership. 4. Vocation. 5. Citizenship. 6. Worthy use of leisure. 7. Ethical character."

These are the general objectives of secondary education. Although given in detail in the first section, the special objectives of the High School science course, especially biology, are enumerated here, as they have been outlined by two writers:

Clements suggests attention be given to the findings of the Committee on Reorganization of Science in the Secondary Schools. Their proposals for the objectives of a secondary course in biology were:

(1) The way in which each organism maintains its own life and the life of the species.

(2) The interrelations between different organisms and groups of organisms.

(3) The constant dependence upon and interrelations of living things with the physical world about them.

Dr. Bailey's "General Purposes" were: (1) To gain a basis for the solving and understanding of human problems by studying the life processes of plants and animals. (2) To learn to maintain physical and mental efficiency. (3) To survey vocational opportunities from the standpoint of biology. (4) To gain new interests for the enjoyment of leisure time. (5) To understand the relationship between human beings and the rest of the living world.

Critical comparison of the "seven objectives" of the Reorganization Commission with the above two lists is interesting: (See table on the following page). This table illustrates how the seven objectives are next carried out, in biology, by the special objectives peculiar to such a course. The general units,

or topics, are then to be selected. These, in turn, are to deal with means of reaching the objectives previously listed.

The Seven Objectives	*Bailey*	*Reorganization Commission*
1. Health	(2) Mental and physical efficiency.	?
2. Command of fundamental processes.	(1) To "gain a basis."	?
3. Home membership	(1) Solving human problems.	(2) Interrelations of different organisms.
4. Vocations.	(3) Vocational opportunities.	(2) Possibly.
5. Worth of leisure time.	(4) Leisure time.	—
6. Citizenship.	(1) Human problems.	(1) Possibly.
7. Ethical Character	(1) Human problems.	(1) Possibly.

The list prepared by Bailey, Laton and Turner is:

First Semester:

(1) Interdependence of living things.
(2) Fundamental likenesses.
(3) The metabolic processes, in plants, animals, and man.
(4) Dependence on soil and its conservation.

Second Semester:

(1) How living things differ.
(2) How these differences occur.
(3) The improvement and conservation of living things.
(4) Behavior of living things.
(5) Adjustment to environment.

While other lists are available, the above selection is illustrative of the general conception of an organization which includes topics, themselves necessarily to be broken up, but which can be related directly to the objectives of the course itself, and which also allow correlation with detailed subject matter. These large units are the connecting link between the details of the science and the objectives of the school itself.

THE BIBLIOGRAPHY

Bailey, Edna W., A. D. Laton, A. L. Turner. Loc. cit.
Curtis, Frank D. "A Synthesis and Evaluation of Subject Matter Topics in General Science." Boston. Ginn and Company. 1929.
Clement, Arthur G. "Methods of Teaching Biology." (Univ. of State of N. Y.) *School Science and Mathematics.*

Perry, Winifred. "Biology and Project Work." *School Science and Mathematics: 22:* 51–55. (1922). (An account of work done under Merriam's direction.)

THE SPECIFIC CONTENT

It is not practical to include in such a paper as this the multitudinous details which different authors have worked out for carrying into effect the aims and objectives outlined above. There have been three outstanding contributions to this subject, in its entirety. There have also been a small number of articles with concrete suggestions for valuable means of putting these details into effect. There are literally hundreds of published articles on both aspects of the question of content. These range in value from the worthless contribution of one man who rearranged certain aspects of T. H. Morgan's work with Drosophila without proper acknowledgment, to certain crisp suggestions of great originality.

A. THE SPECIFIC CONTENT OF THE COURSE AS A WHOLE

Bailey, Edna W., Alice Lee Turner, Anita D. Laton. "Biology in the Reorganization of High School Sciences." *University High School Journal*, Oakland, Calif. *4:* 35–45. (1924). (This work is distinguished by its topical organization, and by its organization upon the basis of the above developed objectives of the course in Secondary Biology. The topics are so chosen that the teachers are able to find in the course room for their own background. Thus there is a fusion of the aims of the professional educator and the specialized subject of biology. The general topics are too large to be handled as such, and are to be broken up into smaller units, according to the authors.)

Hunter, G. W. "Report on the Committee on a One-Year Fundamental Course of Biological Science." *School Science and Mathematics: 23:* 656–664. (1923). (Ninety-eight special topics under nine general headings selected. A Survey was then made of various schools to determine which were giving the instruction selected. This was one of the outstanding contributions to the subject of the biology course as a whole. The general form and plan is not unlike the Bailey et al report.)

Persing, Ellis C. "Report of the Committee on Reorganization of the Biological Sciences, Appointed by the Cleveland Biology Teachers' Club." *School Science and Mathematics: 24:* 241–246. (1924). (Divides the year course into eleven general units. Under each is a series of topics to develop the unit.)

Besides the above three references, the following book, containing abstracts of two of the above, and scores more, is of distinct value:

Curtis, Francis D. "A Digest of Investigations in the Teaching of Science." Philadelphia. 1926. P. Blakiston's Son and Co.

B. THE SPECIFIC CONTENT. SPECIAL TOPICS

The average biology teacher knows the usual topics given in the courses in the subject. The college courses, special directions as are included in such works as the three above, and the teacher's experience will have combined to produce most of the information needed for carrying out of special topics. It is sometimes difficult to obtain "tips" on interesting details of enrichment or embellishment of the course. The topics listed below are for the latter purpose, and are not meant to be a complete survey of topical material, which would be impossible.

Allerdice, Ruth. *A School Greenhouse. School Science and Mathematics: 30:* (5) 502–504. (1930). (Grew turpentine pine seedlings, desert plants,—used school heating plant.)

Benedict, Ralph C. "Some Contributions of Technical Research in Elementary Biology." *School Science and Mathematics: 31:* (2) 146–151 (1931). Suggests certain materials for work taken from *American Journal of Botany, Journal of Heredity, Journal of Economic Entomology.* (This appeals because research is the most fruitful and up-to-date source of information which can be obtained aside from going directly to the natural objects. Other periodicals might be added.)

Cairns, Laura. "A Scientific Basis for Health Instruction in Public Schools." Berkeley, Calif. Univ. of Calif. Press. (1929). (This fits in with one of the major objectives of a high school biology course.)

Coleman, L. F. "Manual for Small Museums." New York. Putnam. (1927) 395 pp. Price five dollars. (The U. S. Bureau of Public Documents, and the National Museum, and the Museum of Vertebrate Zoology at Berkeley can furnish the same information at much less expense.)

Durst, Ethel. "Mathematics in Nature." *Univ. High School Journal: 8:* 75–84. (1928). (Modern medicine will need more and more mathematical training. Modern biology will rapidly become mathematical, due to its physical and chemical interpretation. Miss Durst's work may serve to impress these facts on the students in secondary biology.)

Gunthrup, Horace. "Bird Study in the Mississippi Valley." *School Science and Mathematics. 20:* (5) 383–391. (A statistical study of membership in the A. O. U., Wilson and Cooper clubs, by states. Also of courses about birds in certain universities.)

Hull, Edwin D. "Aquarium Plants. Their Habits and an Account of Some New or Little Known Species of Merit." *School Science and Mathematics: 32:* (2) 143–148. (1932). (Hull lists the following groups of plants: Non-Evergreen: *Utricularia vulgaris* (Bladderwort); *Myriophyllum verticillatum* (Water Milfoil); One Duckweed—*Spirodela-polyrhizal.*)

Evergreens listed in five groups:

(1) Plant resting in soil, entirely submerged, can use clean sand for soil: including: Fish grass (*Cabomba*, sp.); Water weed (*Elodea* sp.), *Anacharis*, Water Milfoil, and Vallisnera spiralis.

(2) Not resting or rooting in soil, but on the bottom: Hornwort.

(3) Plants resting on the soil, sometimes submerged, sometimes out of the water: a) Water Purslane (*Ludwigia*); Spike Rush (*Eleocharis*), Water Cress.

(4) Float below surface: *Wolffia, Lemna, Riccia.*

(5) Floating water-ferns. *Azolla, Salvinia.*

Those plants in groups 1 and 2 are the best for oxygenation of water.

Laton, Anita Duncan. "The Psychology of Learning applied to Health Education through biology." Bureau of Publications. Teachers' College, Columbia University. 1929. vi plus 103 pages.

Johnson, Myrtle E. "Salt Water Aquaria for the School Laboratory." *School Science and Mathematics: 20:* (1920) 779–781.

Hubbard, H. R. "How can sex instruction which high school boys and girls need be given in connection with biology." *School Science and Mathematics: 19:* 150–157. (1919). (Begins with frog—then beans, bacteria, mammals.)

Miller, D. F. "Out of Season Materials for the Biology Class." *School Science and Mathematics: 29:* (1929) 470–473. (Hay and straw infusions, sponges, hydra, parasites of wild rats, snails.)

Miller, D. F. "An Artificial Ant Nest As a Project in the Teaching of Biology." *School Science and Mathematics: 29:* (1929) 256–259. (Must be tight for the first few days until ants acclimated.)

Smith, Frank. "Interesting results from bird banding activities." *School Science and Mathematics.* XXV. (6): 569–573. (1925). (The Western Bird Banding Society, of more direct use in California, has headquarters at the Museum of Vertebrate Zoology, Univ. of Calif. It publishes a periodical available for a dollar a year.)

McSpadden, W. W. and Miller P. Mayhall. "The Age of Mammals and Man." *School Science and Mathematics: 30:* (3). (1930) 301–307. (This is the most important publication of the record of the above two pages. It is the result of cooperation between a professional anthropologist in the University of Texas and a High School teacher in developing the material for a single unit.)

Walton, Arthur C. "The Nematodes As Teaching Material." *School Science and Mathematics: 21:* (1921) 565–577. (1921). ("Take a little dirt . . . place in moistened, glass dish. Cut up a few bits of raw meat —or earthworm—spread over soil. Keep soil damp. In three to five days decaying bits organic material will be covered with . . . nematodes. Transfer to a peptone solution with some decayed meat. Bacteria act on peptone furnishing food for the nematodes.")

THE TEACHING PROCEDURE

"It seems obvious that no one method should be used to the exclusion of other methods of instruction."—Jerome Isenbarger.

The "Handbook" of the Department of Science, University High School, University of California, lists various teaching methods. The following list is practically the same as that in the Handbook, with a few deviations and a few larger topics:

The methods available are: Class discussion, teacher and student demonstration, text or supplementary assignments, visual

methods—slides, moving pictures—Field trips and excursions—Special or individual laboratory work, models, charts, lectures, drawings, various "unit-plans," "contracts," "projects" and special investigations. Testing of the class is an important part of the teaching procedure. The library is important, as well.

Some experimental studies of the value of teaching procedures follow:

1. Visual Education:

Freeman, Frank N. A Scientific Study of Visual Education. *Journal of Educational Research: 10:* (5) 375–385. (1924). (Slides plus talk or recitation the most effective method of using visual aids. Results indicated method highly efficient.)

Woolf, Paul. "The Use of Visual Aids in Education." *University High School Journal: 8:* 122–154. (1928). (Complete discussion with bibliography.)

2. Field Trips—Notes on Managing:

Persing, Ellis C. "Notes on Managing Field Trips." *School Science and Mathematics: 20:* (1920) 797–800. (With a sample page of directions on study of weeds. Advocates smaller topics and more trips.)

3. Lecture-demonstration Versus Individual Laboratory Method:

Anibel, Fred G. "Comparative Effectiveness of the Lecture-Demonstration and Individual Laboratory Method." *Journal Educ. Research: 13:* 355–365. (Finds lecture-demonstration more efficient.)

Cooprider, J. L. "Teacher versus Student Demonstrations in High School Biology." *School Science and Mathematics: 26:* 147–155. (1926). (Good students obtain as good results as does the teacher. Poorer students do not.)

Hunter, G. W. "The Problem of Method in Elementary Biology." *School Science and Mathematics: 27:* (1927) 594–605. (City children preferred teacher demonstration more often. Country children preferred field excursions more often.)

Isenbarger, Jerome. "Lecture-Demonstration-Recitation Technique in Biology Teaching." *School Science and Mathematics: 25:* 618–622. (1925). (Quoted on preceding page.)

4. Units:

Corbally, John E. "A comparison of Two Methods of Teaching one Problem in General Science." *The School Review: 38:* 61–66. (1930). (Results of experimental tests with the Morrison plan and assignment-recitation plan were concluded with the results that most of the differences in results are due to the teacher and not to any "plan" of teaching.)

Weber, Lynda. "The Use of the Unit-Contract System in Teaching Biology." (University High School, Madison Wisconsin) *School Science and Mathematics: 28:* 399–413. (1928). (Gives an interesting example of a topic worked out in foods.)

5. Drawings, Charts, etc.:

Carnegie Foundation. Reported in *Phi Delta Kappa News*, Univ. of Oregon, 1931. (Experimental results with the department of Animal

Biology were sufficiently convincing to the Zoologists that they have practically abandoned all laboratory drawings on the grounds that it wastes time to make detailed drawings of slides and prepared materials. This change occurred only at the University of Oregon due to this particular study.)

Miller, Ward. L. "Shall Biology Students Draw or Not?" *School Science and Mathematics: 28:* 247–254. (1928). (An article of the type commencing "For the past several years" and ending by thinking drawings should stay. No experimental evidence.)

Hueber, Dorothy E. "A Comparative Study of the Effectiveness of Models, Charts, and Teacher's Drawings in the Teaching of Plant Structures." *School Science and Mathematics: 29:* (1929) 65–70. (Believes good teacher's drawings an aid. Models better than charts, and teacher's drawings better than charts. All visual aids of value.)

6. Testing:

Approximately ten outstanding articles are in this category. For the average condition at present, however, an application of the principles of testing, as given earlier in the paper, would be more effective than attempting to utilize a test prepared some time preceding its use, since biology is a rapidly changing subject.

THE TRAINING OF TEACHERS OF CHEMISTRY IN TEACHERS COLLEGES

By Willis J. Bray
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The growth of teachers colleges into standard four-year institutions conferring the bachelor's degree has brought large responsibility for the preparation of high school teachers. The present investigation was begun for the purpose of ascertaining something of the character of the curricular offerings of teachers colleges in their effort to meet this responsibility.

During the winter of 1930–1931 a careful study was made of the catalogs of ninety-five of the teachers colleges of the United States having Class "A" rating with the American Association of Teachers Colleges. These data were collected by the writer in collaboration with his colleague, Professor Wray M. Rieger. All courses in chemistry offered by each of these 95 colleges were listed by title and credit. The credit, regardless of the unit of measurement used, was translated into semester hours for the sake of ready comparison and study. Courses were grouped so far as possible into the general classifications ordinarily used. For example, all beginning courses in chemistry were listed as General Chemistry, although there was much lack of uniformity

in nomenclature observed. It was found that a number of colleges gave Qualitative Analysis with General Chemistry, though the large majority of the institutions offered Qualitative Analysis as such.

It was found that 66.4 per cent of the colleges studied offered a major of at least 24 semester hours in chemistry, while 15.8 per cent of the institutions, even though they offered no major in the subject, offered a minor of at least 15 hours. This indicates that 82.2 per cent of the colleges studied are making a definite effort to prepare teachers of chemistry, while only 17.8 per cent offered less than a minor in chemistry. The average number of semester hours in chemistry offered was 31.5. Several of the colleges offer some graduate work in chemistry, though this number is a very small minority. One college offered 6 hours in chemistry, two others offered 8 hours, and another 9 hours, while one offered 102 hours in the subject. The range is thus seen to be 96 hours. Table I shows the distribution of semester hours in chemistry offered.

TABLE I
DISTRIBUTION OF SEMESTER HOURS IN CHEMISTRY OFFERED

Hours	*Frequency*	*Hours*	*Frequency*
100–104	1	45–49	8
95–99	0	40–44	5
90–94	0	35–39	12
85–89	0	30–34	10
80–84	2	25–29	11
75–79	0	20–24	12
70–74	1	15–19	7
65–69	1	10–14	14
60–64	1	5–9	5
55–59	1		
50–54	4		

$N = \ldots\ldots 95$
$Md. = 29.3$
$Q_1 = 18.4$
$Q_3 = 42.25$

It is seen that there are only 19 colleges offering a number of hours in chemistry above the 75 percentile point, while there are also 19 colleges having offerings in chemistry smaller than that indicated by the 25 percentile point. The median number of semester hours of chemistry offered was found to be 29.3.

Table II shows the courses offered by these colleges, indicating the mean number of semester hours offered in each course, and the percentage of the total number of colleges offering that course.

It is interesting to note the relatively large number of courses offered in other than the generally recognized fundamental fields of chemistry. It is probable that some variation in offerings is to be encouraged, especially where such can be made to serve local peculiar needs. It seems certain to the writer, however, that in no case should offerings in such courses be permitted to supplant those in the four or five fundamental fields of chemistry. Courses in Plant Physiology and Home Economics were listed in the table because there were two colleges in which the Chemistry Departments offered these courses.

TABLE II

MEAN OF OFFERINGS IN THE SEVERAL COURSES IN CHEMISTRY

Course	*Mean Offering in Sem. Hrs.*	*% of Colleges Offering Course*
General Chemistry	9.9	100
Organic Chemistry	5.7	87
Qualitative Analysis	5.0	66.4
Quantitative Analysis	5.25	75.8
Physical Chemistry	5.5	21.5
Physiological Chemistry	3.2	31.6
Teaching of Chemistry	3.0	33.7
Household Chemistry	3.5	33.7
History of Chemistry	2.75	12.65
Industrial Chemistry	3.2	16.85
Textile Chemistry	2.5	11.6
Agricultural Chemistry	2.75	11.6
Food Analysis	2.65	13.7
Water Analysis	2.35	11.6
Applied Chemistry	2.9	14.75
Literature of Chemistry	1.6	8.4
Food Products	3.15	23.15
Laboratory	2.65	3.16
Oil Chemistry	2.0	5.26
Calculations	2.4	3.16
Projects	2.0	2.14
Home Economics	4.65	2.14
Plant Physiology	2.3	2.14
Inorganic Preparations	3.5	7.37
Organic Analysis	3.5	2.14
Gas and Fuel Analysis	2.8	2.14
Organic Preparations	4.6	5.26
Research	6.3	3.16

CONCLUSIONS

1. This study seems to indicate that curricular offerings in chemistry in Class "A" teachers colleges are quite adequate for the preparation of teachers of high school chemistry.

2. There is much lack of uniformity in nomenclature, particularly as regards the beginning course.

3. That Organic Chemistry, Qualitative Analysis and Quantitative Analysis are quite generally recognized as being fundamental courses in the training of chemistry teachers.

4. The tendency to offer many courses in various phases of applied chemistry in teachers colleges is probably open to question, unless such offerings are over and above a major in the more fundamental courses.

5. The tendency to offer such courses in applied chemistry is not found in a very large percentage of the teachers colleges.

6. That, where local conditions require, such courses as Industrial Chemistry, Textile Chemistry and Agricultural Chemistry may properly be encouraged where fundamental scholarship in the science is not sacrificed.

7. There is a definite trend in the direction of graduate work in the teachers colleges.

8. Thirty states are represented in this study by 95 standard four-year colleges whose primary object is the education of teachers.

9. While only 33.7 per cent of the colleges offer a course in the Teaching of Chemistry, several others offer a course in the Teaching of Science.

10. It seems evident that a much larger number of teachers colleges should make some provision for presenting to prospective teachers the principles of the teaching of chemistry.

A LABORATORY SUGGESTION

M. J. McHENRY
Hendrix College, Conway, Arkansas

The cost of a glass stoppered reagent bottle is too well known to require comment. Students often in attempting to open such a bottle break off the stopper flush with the top of the container. We have been able to remove such frozen plugs with almost 100% success in the following way.

Acidify strongly with hydrochloric acid a beaker of water. Turn the bottle upside down in the water and let soak for a day or two. Take out, dry, warm the neck and tap the neck gently on the inside wall of a sink.

THE MATHEMATICAL ASSOCIATION OF AMERICA

The following have been elected officers of the Mathematical Association for 1933:

President (for 2 years): Professor Arnold Dresden, Swarthmore College.

Vice-Presidents: Professor A. A. Bennett, Brown University, and Professor E. B. Stouffer, University of Kansas.

Trustees (for 3 years): Professor B. F. Finkel, Drury College; Professor W. L. Hart, University of Minnesota; Professor E. J. Moulton, Northwestern University.

W. D. CAIRNS

PREPARATION OF VISUAL TESTS

By Clyde Stewart
Lancaster, Wisconsin

A great many commercial films, slides, and film slides are unfit for classroom use. They are primarily an advertising medium and oftentimes the material given in them does not fit in with the class work, is not available at the time it is needed, or is not organized and written up from the pedagogical point of view. These objections have caused visual material to fall into disfavor among some educators. A careful use of visual material will pay large dividends in student motivation and learning.

To combat the entertainment idea that a few students have regarding screen visual material tests should be given on all material the same as on the regular class work. I think a carefully prepared test should accompany every box of slides, film slides, and motion picture film. Students should be urged to take notes on the material. This promotes closer attention to details which might otherwise escape their notice.

There are several methods of testing that can be used with slides or film slides. One method is to project material on to the screen and have students answer questions about it orally or on paper in the semi-darkened class room. The views can also be projected on to a blackboard and have pupils write in parts on the pictures or diagrams. For instance suppose you were teaching the location of certain important geographical centers. A blank map of the United States could be projected on the blackboard and pupils asked to step up to the board and write in names of the important cities or states. In all forms of testing with a projector too dark a room should be avoided. If the projector is not suitable for semi-darkness such testing methods are perhaps questionable.

Another method that can be used successfully is to set up the projector after school and project a diagram on to the blackboard then while the image is on the board trace it in with chalk leaving out certain essential points. Oftentimes some student from another class who is interested in drawing will do the tracing for the teacher. Parts of the diagram are then labeled or numbered and it can be used the next day as the basis of a test. (See the diagram and test figure.)

Tests from film slides can be placed on a mimeograph stencil with much the same method. If the projector has a lens mount

that will permit the lens to move forward quite a distance so a small image can be formed this image can be projected on to a mimeograph stencil or duplicator paper and traced in. Thus a great number of copies of the test can be prepared. If the students are then required to put their answers to questions on a separate sheet of paper the test questions can be collected after the test is given and saved for the next years' work.

With lantern slides the diagrams are often large enough to be transferred directly to the mimeograph stencil without enlargement with the projector. This can be done very easily by putting the slide up to a window with the stencil over it. Enough light will shine through so one can trace the diagram. The whole test should be made largely or entirely objective whenever possible to simplify the marking of papers. When the tests are to be used year after year a teacher feels justified in spending more time and making up tests carefully. Such tests should be carefully filed for future use.

Below is given an example of a blackboard or mimeograph test that makes use of a partly completed diagram given in the figure.

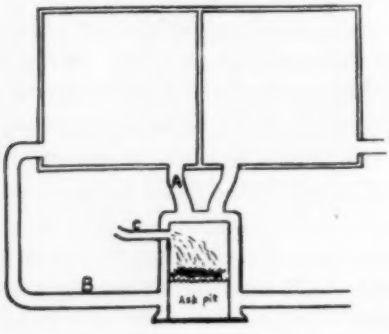


Fig. 1

A Visual Test on Heating Plants

1. The heating plant illustrated above is (1) a pipeless system (2) a pipe hot air system (3) a steam system. ( )
2. The air at (A) is moving (1) up (2) down. ( )
3. The air at (A) is (1) hot (2) cold (3) average temperature. ( )
4. The air at (B) is moving (1) to the right (2) to the left. ( )
5. The circulation of the air in this system is described by scientists as a ..... current.
6. Is there any connection between pipe (C) and pipes (A) and (B)? Answer yes or no. ( )

7. Is this system of heating cheaper to install than a steam heating plant? Answer yes or no. ( )

Many of the questions will tie up with the text book and it is desirable that text material should be taught before the visual work is given. This test was used for a daily quiz with a diagram traced on the board.

SOME RECOMMENDATIONS OF THE CITIZENS' CONFERENCE

Local governments and local school districts should be reorganized and consolidated.

Administrative control of the schools must be centralized in the superintendent.

State administrative organization of education must be reorganized through creation of a non-political and professional agency for administration of educational policies.

The State must assume the responsibility . . . assuring adequate public education to all local communities. . . .

We especially urge law-making bodies to give priority to legislation which will alleviate conditions in communities now being required to make injurious curtailments in their school programs because of unusual burdens, inequitable tax systems or faulty fiscal machinery.

We urge Congress to provide for Federal assistance through emergency loans for a limited period to such States as may make an adequate showing of their inability to maintain reasonable standards of support for public school education.

. . . immediate reformation of the system of taxation.

Immediate efforts should be made through the raising of the general level of commodity prices, the correction of serious economic maladjustments, and otherwise, to increase the volume of income and purchasing power, and thus to provide the moneys necessary for a proper educational program. If this is not done, wide-spread injury will result, not only to the cause of education, but to the value of all obligations, public and private. . . .

. . . recommends . . . consideration by another conference . . . of steps . . . for increasing the level of income and of purchasing power.

. . . opposed to the shortening of the school year below the term existing previous to the depression. . . .

The teaching load should not be increased either in courses or hours, beyond the ability of the individual teacher to offer a reasonable standard of instruction to each pupil, and should be adjusted in relation to the quality of supervision, the experience and qualifications of the teacher, the provisions for exceptional pupils, and the methods of grouping pupils.

. . . postponing of building construction . . . reorganization of business departments; . . . adjustment of the size of class; and . . . curtailing of the activities of auxiliary agencies, etc. . . . before readjustment of teachers' salaries. . . .

Readjustment of salaries, if necessary, should be made in relation to the reduction in the cost of living of the teaching group in any given community. . . .

Consideration should be given in a long term building program to the fact that unit costs are probably at a minimum. . . .

Careful study should be made of the purchase, distribution, and utilization of fuel and other supplies used by building employees. . . . The number of building employees should be kept at what is actually needed. . . .

SOME METHODS IN GERMINATION EXPERIMENTS

By Franklin R. Myers
Science Instructor, Bernards High School
Bernardsville, New Jersey

The story of the resumption of active life in the seed is one that offers much insight into the life processes of plants and should not be neglected as a part of the biology course. We have used this year, perhaps not new methods in this study but at least a combination of methods that may be of interest and value to others with possibly limited room for extensive individual experiments. As far as possible each student has done his own work. A person is always more interested in the seed he sprouts than in the one the instructor prepares for him.

Each student brought from home a square foot of muslin sheeting or toweling to construct a rag doll seed germinator. Inch squares were ruled in pencil to accommodate up to 25 or 30 seeds if desired. To lessen chances of molding, ordinary absorbent paper towels were placed over the seeds and the entire rag doll was rolled up loosely, the paper toweling coming thus between the seeds. Cloth strips served to secure the roll.

Five field corn kernels soaked 2 days were first germinated. The progress of the seeds was watched and drawings made as the stages appeared. Seedlings attained the stage of brace roots, after which they were placed $\frac{1}{2}$ inch deep in 3 inch pots by each student. The later stages were then conveniently followed. The pupils had the satisfaction of seeing their own plants establish themselves. In proportion to the care they gave the seedlings, they were rewarded with good typical specimens. Five beans of the valentine variety were also placed in the rag doll germinators for the early stages. Others were planted in the ordinary flats a few days apart for the later stages. No attempt was made to transplant these from the germinators to the pots, though this might be feasible. While waiting for the development of the seeds, experiments were begun on the factors of air, moisture and temperature needed for germination.

It may be thought that in the class of 65, that the number of rag dolls and pots would constitute a cluttering up of the laboratory. On the contrary with our average size room of $27' \times 15'$ containing 6 laboratory tables they were not found to hinder normal movement about the room. The rag dolls of each class

were placed on the tables in galvanized iron trays 20″×25″. There was also sufficient room on the tables for the pots. Moistening every day kept the seeds under the proper germination conditions.

Even after observing all sprouting stages, students frequently are not aware of the tremendous absorptive power of seeds which precedes active growth. At this point we therefore found it worth while for each student to measure the width of 4 beans of the valentine variety, and the largest diameter of 2 peas. The beans of this variety serve well the purpose of this experiment because they may be obtained with testas of two colors—one type with red testa, the other with a black testa. In this way they can be distinguished more readily. These were measured before and after a day's soaking, and the percentage increase computed. Pupils were greatly surprised with the results of this experiment.

The experiment of the micropyle as a source of water entry into the germinating seed was easily combined with the above. Two beans of the black variety were vasolined while two others of the red variety were not vasolined at the micropyle. The individual results in this experiment did not clearly show in each case that the seed had absorbed greatly less water than the unvasolined one, but the entire class sampling did so.

The problem of keeping soil in the laboratory, and real soil seems to me more desirable than its substitutes, was solved by the construction in the Manual Arts department of 5 sheet metal soil containers 12″×12″×8″ which conveniently fitted on the bottom shelf of the store room. Regular greenhouse "flats" or growing boxes 12″×12″×3″ served to grow beans or corn in quantity.

We feel that the three or four weeks time given to the study of the beginning of life in plants is not excessive in our community for the school population is one from the homes of farmers and gardeners and other workers to whom, as to others this phase of the work is both instructive and inspiring.

The standard rag doll seed germinator is described in Farmers Bulletin No. 948. This and the method of testing viability of seed corn by the sampling of five middle kernels of each ear were explained. Several students then proceeded to test their neighbor's seed ears as a practical experiment.

The use of the individual rag doll method in the germination work has evoked real interest on the part of the students. They

come each day anxious to see what progress might be noted in the growing seeds. They have without direct encouragement proceeded to construct other germinators of their own and to test seeds other than those of our experiments. When such practical outcomes follow class or laboratory work of this kind we are encouraged that our methods have not been without some degree of success.

PROBLEM DEPARTMENT

CONDUCTED BY G. H. JAMISON
State Teachers College, Kirksville, Mo.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor, should have the author's name introducing the problem or solution *as on the following pages.*

The Editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.

SOLUTIONS OF PROBLEMS

Note.—Persons sending in solutions should read carefully the instructions about the form of the solutions and the ink-drawn figures. Many times, a good solution is received, but poorly arranged and no India-ink figure given.

LATE SOLUTIONS

1249. John E. Bellards, St. Nazianz, Wis., William Wernick, Bronx, N. Y., K. R. Mutch, Glen Rock, Pa., Cecil B. Read, Wichita, Kans.

1255. K. R. Mutch, Glen Rock, Pa., Guy C. Lentini, Boston, Mass., Chas. W. Trigg, Los Angeles, Calif.

1248. H. R. Mutch, Glen Rock, Pa., Guy C. Lentini, Boston, Mass., John E. Bellards, St. Nazianz, Wis.

1256. *Proposed by R. T. McGregor, Elk Grove, California*

If a, b, c, be in harmonic progression, and n be a positive integer, show that $a^n+b^n>2b^n(n>1)$

Solved by W. E. Buker, Box 66, Leetsdale, Pa.

SOLUTION: Let $a=-2$, $b=4$, $c=1$, $n=3$.
Then $a^n+c^n=(-2)^3+(1)^3=-7$
$2b^n=2(4)^3=128$.
Here $a^n+c^n<2b^n$, and the problem as stated is not always true.

1257. *Proposed by H. Grossman, New York City.*

Construct a triangle having given h_a, t_a, and m_a.

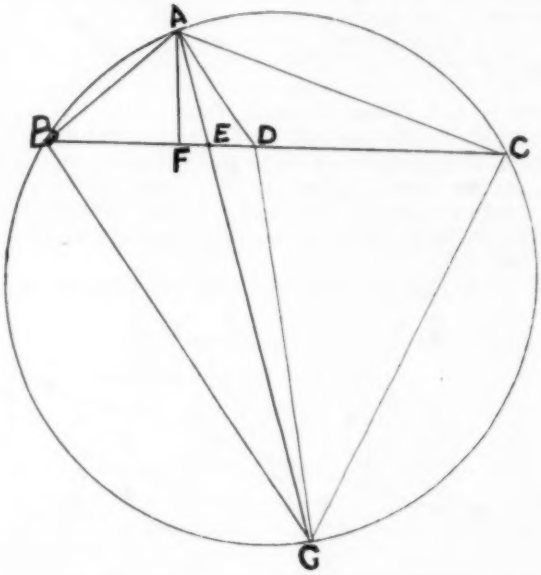
Solved by C. C. Hunt, Cedar Rapids, Iowa

Construct the right triangles AFE and AFD, in which $AF = h_a$, $AE = t_a$.

From D construct a perpendicular to FD and let G be the point in which this perpendicular interesects AE produced. (Unless the required triangle is isosceles, this can be done.)

Find the mean proportional between AG and EG, and from G draw oblique lines, GC and GB to FB produced if necessary, which shall each be equal to the mean proportional thus found.

Draw AC and AB, and ABC will be the required triangle.



PROOF: AF, AE, and AD are equal to h_a, t_a and m_a respectively by construction, and $AF \perp BC$ (Construction) and $BD = DC$ (Right triangles BDG and CDG are equal). Therefore AF is the altitude and AD the median of triangle ABC.

It remains to prove that AE bisects $\angle BAC$.

In triangles ACG and ECG, angle AGC is common and by construction $EG:CG::CG:AG$. Therefore, the triangles are similar, and $\angle ECG = \angle CAG$. —But $\angle ECG = \angle CBG$. Therefore $\angle CBG = \angle CAG$. Then a circle constructed on CG as a chord subtending an angle equal to $\angle BCG$, will pass through A and B, and will therefore be circumscribed about the triangle ABC.

Therefore $\angle BAE = \angle GAC$ (Subtended by equal chords).

Therefore $AE = t_a$ is the bisector of angle BAC.

Also solved by W. E. Buker, Leetsdale, Pa., O. B. Kraemer, Battle Creek, Iowa, D. Moody Bailey, Athens, W. Va., Benjamin Bruverman, Brooklyn, N. Y., and John E. Bellards, St. Nazianz, Wis., and Charles W. Trigg, Los Angeles, Calif.

1258. *Proposed by Norman Anning, University of Michigan.*

Find three integers other than K, K, K, which are in arithmetic progression, geometric progression, or harmonic progression according to the order in which they are taken.

Solved by W. E. Buker, Box 66, Leetsdale, Pa.

SOLUTION: Let a, b, c, be the three integers, and let a, b, c, be in arithmetic progression, while c, a, b, are in geometric progression. Then,

$$a+c=2b \tag{1}$$
$$bc=a^2. \tag{2}$$

Solving, we get $a=b, \quad -2b$
$c=b, \quad 4b.$

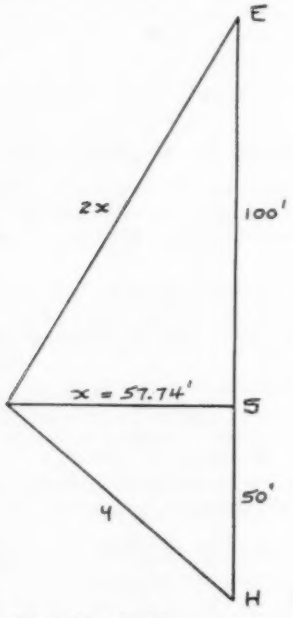
The first solution is to be eliminated, so we have $-2b$, b, and $4b$ in arithmetic progression, while b, $4b$, and $-2b$ are in harmonic progression and $4b$, $-2b$, and b are in geometric progression.

Also solved by Charles W. Trigg, Los Angeles, Calif., and D. Moody Bailey, Athens, W. Va.

1259. *Proposed by S. I. James, Nashville, Tenn.*

An eagle, a hawk, and a sparrow are in the air. The eagle is 100 feet above the sparrow and the hawk is 50 feet below it. The sparrow flies straight forward in a horizontal line. The eagle and the hawk start at the same time towards the sparrow. The eagle flies twice as fast as the sparrow. If the eagle and the hawk reach the sparrow simultaneously, how far does each of the three fly?

Solved by D. Jerome Lochman, University of Chicago High School



$$x^2+100^2=(2x)^2$$
$$3x^2=10000$$
$$x^2=3333.3333$$
$$x=57.74$$
$$\therefore 2x=115.48$$
$$y^2=50^2+x^2 2500+3333.33=5833.33$$
$$y=76.38$$

The eagle flew 115.48 feet.

The sparrow flew 57.74 feet.
The hawk flew 76.38 feet.

Also solved by Hansen Smith, Battle Creek, Iowa, Bill Rogers, Frankfort, Mich., Charles W. Trigg, Los Angeles, Calif., and Ruth Otto, Harrison, Ohio.

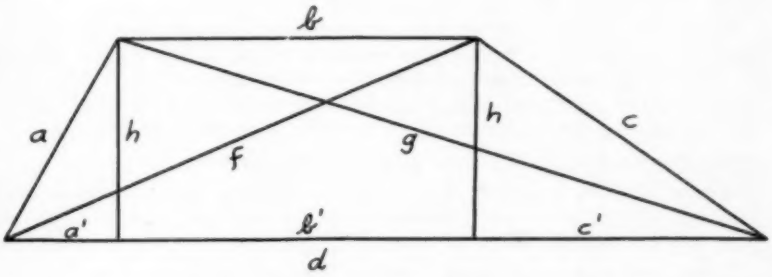
1260. *Proposed by Albert Whiteman, Philadelphia, Pa.*

Determine a trapezoid such that the four sides, the altitude and the two diagonals are all integral.

Solved by Charles W. Trigg, Cumnock College, Los Angeles, Calif.

In the triangles aha' and chc', since a, c and h are integral a' and c' are either integral or the square root of an integer. Since $b=b'$ and is integral as is also d, a' and c' cannot be irrational, for a rational number cannot be the sum of a rational number and an irrational one. Hence, a' and c' must both be integral.

The problem is thus resolved into the discovery of different right triangles having the same integral base, h, and integral sides and hypotenuses. Other conditions are imposed by the type of trapezoid desired. For an isosceles trapezoid, it is only necessary to find 2 such triangles. For a scalene trapezoid, 4 triangles are necessary, with sides such that the sum of the sides of 2 of them equals the sum of the sides of the other 2, i.e., $f'+c'=a'+a'$, where f', c', etc. are projections of f, c, etc. on the lower base.



If one of the sides of the trapezoid is h, then 3 triangles are required, the sum of the sides of two equalling the side of the third. If the trapezoid have an obtuse base angle, then 4 triangles are needed, the sum of the sides of three of them equalling the side of the fourth. (In this discussion, "side" is used to distinguish the third side of the triangles from the base and hypotenuse.)

Examination of right triangles with integral bases from 1 to 25 reveals that only those with bases (=altitude of the trapezoid) of 8, 9, 12, 15, 16, 18, 20, 21, 24, and 25 meet the conditions imposed. These yield a total of 52 isosceles trapezoids, but only 24 gives an ordinary scalene trapezoid (the one given in No. 1186, February 1932) and three scalene trapezoids with one obtuse base angle. These latter would appear to be ${}_3P_2$ but three of them are inverted forms of the other three. If mirror images be considered, four more scalene trapezoids are secured.

The process may be continued indefinitely, although as far as carried no general method became apparent. Obviously, trapezoids meeting the conditions exist whose lines are multiples of those identified, but there will be others as well.

The dimensions of the triangles and of the corresponding trapezoids are given in the table on page 333.

Also solved by D. Moody Bailey, Athens, W. Va.; C. C. Hunt, Cedar Rapids, Ia.; W. E. Buker, Leetsdale, Pa.

HIGH SCHOOL HONOR ROLL

The editor will be very happy to make special mention of high school classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

For this issue the Honor Roll appears below:

1259. Ruth Otto, Harrison (Ohio) High School; Hansen Smith, Battle Creek (Iowa) High School, Bill Rogers, Frankfort (Mich.) High School.

1257. John H. Ballantine, Jr. and Wolsey Cenmalt, both from Taft School, Watertown, Conn.

1260. Hansen Smith, Battle Creek (Iowa) High School.

1242–1249. John H. Ballantine and Thomas Riggs, Jr., both of Taft High School, Watertown, Conn.

1249. Louise Kunkle, Johnstown, Pa., and Wolsey Cenmalt, Watertown, Conn.

PROBLEMS FOR SOLUTION

1274. Proposed by Murble Pearson, Norman, Oklahoma.

Given the triangle ABC with the centroid G. Through the centroid any line XY is drawn and through the vertex A, a line MN is drawn parallel to XY. From vertex B, a perpendicular BP is dropped upon MN, and from vertex C, a perpendicular CQ is dropped upon XY. To prove that the line RS joining she midpoints of PC and BQ is bisected by line XY.

1275. Proposed by Paul Veigle, Loretto, Pennsylvania.

A room is 40 ft. long and 20 ft. wide. What is the length of the longest rectangular strip of carpet that can be laid along the diagonal of room? The width of carpet is 3 feet.

1276. Proposed by William Wernick, Bronx, New York.

We have an isosceles right triangle with hypotenuse equal to a. With each of the equal legs as a hypotenuse, two new isosceles right triangles are constructed, with the vertex of the right angle outside the original triangle. With each of the equal legs of the two new triangles as hypotenuses, four isosceles right triangles are constructed, with their vertices outside the original figure. This process is continued indefinitely. Is there a limiting area, if so, what is it?

1277. Proposed by Cecil B. Read, Wichita, Kansas.

(a) A sum of x dollars, invested at x per cent, compounded annually, doubles itself in x years. Find x, other than zero.

(b) Generalize the case where x dollars invested at x per cent compounded annually becomes in x years x times the original amount.

1278. Proposed by L. W. Hulse, Denver, Colorado.

Show that $x^{4p}+x^{2p}+1$ is not a prime number for x any integer except one, and for p, any integer.

1279. From a university list of examination questions for H. S. pupils.

If the digit 7 is written at the right of a certain number that number is increased by 70,000. Find the number.

Right Triangles			Isosceles Trapezoids						
base	side	hypotenuse	a	b	c	d	f	g	h
8	6 15	10 17	10	9	10	21	17	17	8
9	12 40	15 41	15	28	15	52	41	41	9
12	5 9 16 35	13 15 20 37	13 13 13 15 15 20	4 11 30 7 26 19	13 13 13 15 15 20	14 21 40 25 44 51	15 20 37 20 37 37	15 20 37 20 37 37	12
15	8 20 36 112	17 25 39 113	Yields ${}_4C_2=6$ trapezoids, calculated from the triangles by— a = shorter hypotenuse	longer side minus shorter side	shorter hypotenuse	longer side plus shorter side	longer hypotenuse	longer hypotenuse	base
16	12 30 63	20 34 65	Yields ${}_3C_2=3$ trapezoids						
18	24 80	30 82	30	56	30	104	82	82	18
20	15 21 48 99	25 29 52 101	Yields ${}_4C_2=6$ trapezoids						
21	20 28 72 220	29 35 75 221	Yields ${}_4C_2=6$ trapezoids						
25	60 312	65 313	65	252	65	372	313	313	25
24	7	25	Yields ${}_7C_2=21$ trapezoids						
	10	26			Acute scalene trapezoid				
	18	30	25	38	40	77	51	74	24
	32	40			Obtuse scalene trapezoids				
	45	51	25	25	51	63	30	74	24
	70	74	25	52	30	63	51	74	24
	134	145	51	52	30	25	25	74	24

BOOKS RECEIVED

Elementary Mathematical Analysis, by Mayme Irwin Logsdon, Associate Professor of Mathematics, The University of Chicago. Volume II. First Edition. Cloth. Pages ix+188. 15×23 cm. 1933. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York, N. Y. Price $1.75.

Analytic Geometry, by Frederick S. Nowlan, Ph.D., Professor of Mathematics, University of British Columbia. First Edition. Cloth. Pages xi +295. 12.5×18 cm. 1933. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York, N. Y. Price $2.25.

Radio Physics Course, An Elementary Text Book on Electricity and Radio by Alfred A. Ghirardi in charge of Department of Radio Communication and Applied Electricity, Hebrew Technical Institute, New York City. Second Edition Revised and Enlarged. 508 Illustrations. Cloth. Pages xiv+972. 16.5×22.5 cm. 1932. Radio Technical Publishing Co., 80 Fifth Avenue, New York, N. Y. Price $3.50.

Radio Servicing Course, A Practical Concise Text on the Use of Modern Radio Service Instruments and the Rapid and Systematic Attacking of Radio Service Problems by Alfred A. Ghirardi, Department of Radio Communication and Applied Electricity, Hebrew Technical Institute, New York City and Berthram M. Freed, Consulting Radio Service Engineer. 110 Illustrations. First Edition. Cloth. Pages ix+182. 19×12.5 cm. 1932. Radio Technical Publishing Co., 22 West 21st Street, New York City. Price $1.50.

Out of Doors, A Guide to Nature by Paul B. Mann, Associate in Education, American Museum of Natural History, Head of Department of Biology, Evander Childs High School, New York City and George T. Hastings, Faculty Member of Nature Camp, Pennsylvania State College, Head of Department of Biology, Theodore Roosevelt High School, New York City. Cloth. Pages x+448. 12.5×19 cm. 1932. Henry Holt and Company, Inc., One Park Avenue, New York, N. Y.

Biology for Beginners, by Truman J. Moon, Head of Science Department, The High School, Middletown, New York and Paul B. Mann, Head of Department of Biology, Evander Childs High School, New York City. Cloth. Pages x+741+xxxii. 13×19.5 cm. 1933. Henry Holt and Company, One Park Avenue, New York, N. Y.

Volumetric Analysis, by G. Fowles, Assistant Master, Latmer Upper School, Hammersmith. Cloth. Pages xii+202. 12×19.5 cm. 1932. G. Bell and Sons, Ltd., Publishers, York House, Portugal Street, London W.C.2. Prices 6s. Chapter I is available separately. Price 1s.4d.

The Relativity Theory Simplified, by Max Talmey, M.D. with an Introduction by George B. Pegram, Professor of Physics, Columbia University. Cloth. Pages xi+186. 12.5×19 cm. 1932. Falcon Press, Inc., 1451 Broadway, New York. Price $1.50.

My Long Division Drill Book, by Guy M. Wilson, Professor of Education, Boston University. Paper. Pages vi+53. 21×28 cm. 1932. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price 32 cents.

Plane Geometry, by A. M. Welchons and W. R. Krickenberger, The Arsenal Technical High School, Indianapolis, Indiana. Cloth. Pages xiii +370. 13×20 cm. 1933. Ginn and Company, 15 Ashburton Place, Boston, Massachusetts. Price $1.28.

Solid Geometry, by A. M. Welchons and W. R. Krickenberger, The Arsenal Technical High School, Indianapolis, Indiana. Cloth. Pages xi +251. 13×20 cm. 1933. Ginn and Company, 15 Ashburton Place, Boston, Massachusetts. Price $1.24.

Standard Service Arithmetic Work-Book, Grade 6, by G. M. Ruch, College of Education, University of California; F. B. Knight, College of Education, University of Iowa; J. W. Studebaker, Superintendent of Schools, Des Moines, Iowa. Paper. Pages xvii+104. 20.5×28 cm. 1932. Scott, Foresman and Company, 623 S. Wabash Avenue, Chicago, Illinois. Teacher's Edition. Price 48 cents.

Text and Tests in Plane Geometry, A Combined Textbook, Student's Workbook, and Testbook made for modern Courses, by David Eugene Smith, Teachers College, Columbia University; William David Reeve, Teachers College, Columbia University; Edward L. Morss, Editor of Mathematical Textbooks. Paper. 286 pages. 19×26 cm. 1933. Ginn and Company, 15 Ashburton Place, Boston, Massachusetts. Price 88 cents.

A First Course in Calculus, by Edwin S. Crawley and Perry A. Caris, University of Pennsylvania. Cloth. Pages x+342. 15×23 cm. 1933. F. S. Crofts and Company, 41 Union Square, West, New York, N. Y. Price $3.25.

Introductory College Algebra, by H. L. Rietz, Professor of Mathematics, University of Iowa and A. R. Crathorne, Associate Professor of Mathematical Statistics, University of Illinois. Revised. Cloth. Pages xi+305 +23. 13.5×19.5 cm. 1933. Henry Holt and Company, One Park Avenue, New York, N. Y. Price $1.76.

Plane Geometry, by Mabel Sykes, Instructor in Mathematics, Bowen High School, Chicago, Illinois; Clarence E. Comstock, Professor of Mathematics, Bradley Polytechnic Institute, Peoria, Illinois; Charles M. Austin, Head of the Department of Mathematics, Oak Park and River Forest Township High School, Oak Park, Illinois. Cloth. Pages x+460. 13×18.5 cm. 1932. Rand McNally and Company, 538 S. Clark Street, Chicago, Illinois.

Intermediate Algebra, by Joseph B. Orleans, Head of Mathematics Department, George Washington High School, New York City and Walter W. Hart, Associate Professor of Mathematics, School of Education and Teacher of Mathematics, Wisconsin High School, University of Wisconsin. Cloth. Pages vii+294. 12×19 cm. 1933. D. C. Heath and Company, 285 Columbus Avenue, Boston, Mass. Price $1.32.

My First Drill Book in Numbers, by C. L. Thiele, Director of Exact Sciences, Detroit Public School; Irene Sauble, Supervisor of Exact Sciences, Detroit Public Schools. Illustrated by Minnie Hansen Rousseff. Paper. 17.5×23 cm. 1932. Rand McNally and Company, 538 S. Clark Street, Chicago, Illinois.

PAMPHLETS RECEIVED

Achievement in General Chemistry as it is Related to Certain Learning Abilities, by Willis Joseph Bray, Professor of Chemistry and Head of the Division of Science, Northeast Missouri State Teachers College. 85 pages. 15×23.5 cm. 1931. Bulletin of the Northeast Missouri State Teachers College, Kirksville, Missouri. Volume XXXI, No. 6, July, 1931.

Optical Instruments. Catalog L-1. 32 pages. 19×26.5 cm. 1932. Instru-

ments listed in this catalog are for use in both Educational and Industrial Laboratories. The Gaertner Scientific Corporation, 1201 Wrightwood Avenue, Chicago, Illinois.

Sixteenth Annual Report of the Federal Board for Vocational Education, 1932. Pages x+117. 14.5×23.5 cm. For sale by the Superintendent of Documents, Washington, D. C. Price 15 cents.

The Forestry Primer, by Charles Lathrop Pack, President of the American Tree Association, Washington, D. C. 1933 Edition. 32 pages. 15×21.5 cm. American Tree Association, 1214 Sixteenth Street, N. W., Washington, D. C.

Fellowships and Scholarships Open to American Students for Study in Foreign Countries. 58 pages. 14.5×23 cm. 1932. Institute of International Education, 2 West 45th Street, New York, N. Y.

Children's Science Fair, A Project in Science Education, by Morris Meister, Head of Science Department, and Visual Instruction, New York Teacher Training College. 48 pages. 16.5×25 cm. 1932. The American Institute, Lincoln Building, 60 East 42nd Street, New York, N. Y. Price 25 cents.

BOOK REVIEWS

Jobs for the College Graduate in Science, by Edward J. v. K. Menge, Marquette University. 183 pp. Bruce Publishing Company, Chicago, 1932.

As the name indicates, this book is a treatise on work open to men and women college graduates who have specialized in the sciences. The different groups of sciences are treated under the following headings: mathematicians, including the physical and chemical group; the medical group; engineering; and the biological science group.

Each group is subdivided into the different kinds of work which it includes. For example, the discussion of the first group includes the work of astronomer, mathematician, actuary and statistician, physicist, geophysicist, geologist, geographer, meteorologist, and chemist. Under each division are given general nature of the work and necessary preparation of the worker, number engaged in different phases of the work, income, professional organizations, types of positions, and books to consult.

Dr. Menge in this book comes to the rescue of teachers of science who have realized the importance of a source of information with regard to vocations to which training in science may lead. This work, together with those of the extensive bibliography, open a way to answering many questions that are uppermost in the minds of students concerning vocations along science lines.

JEROME ISENBARGER

Bacteria, Yeasts and Molds in the Home, by H. W. Conn; third revised edition, by Harold Conn, Soil Bacteriologist, New York Agricultural Eexperiment Station. 320 pp., 80 figures. Ginn and Company. 1932.

The general plan and purpose of this book remain the same as in previous editions. This third edition brings the book up to date in embodying important changes in the sections relating to refrigeration, canning, and the spread of disease. An introduction taking up the historical aspects of the subject has also been added.

The book does not require an extensive scientific background. It stresses especially those phases of the subject which have a practical importance in the household and in everyday living. The book is standard as a text

in domestic science classes in the high school as a guide to discussion as well as a guide to laboratory work. Biology teachers have made wide use of former editions of this book in the study of bacteria, yeasts, and molds. They have especially found useful the directions for laboratory work which are well adapted for use with high school pupils. Many of the experiments can be used as projects to be done by the students at home. Teachers will find this edition even more useful than former ones.

JEROME ISENBARGER

Zoology Manual, by the Chicago Zoology Teachers in cooperation with the Bureau of Curriculum. 94 pp., thirteen units. Illustrated. Lyons and Carnahan, Chicago. 1932.

The manual is made up of two parts, one intended for use during the fall semester and the other during the spring semester. It includes laboratory assignments and an outline of the work of a year in zoology for the high school.

In so far as possible the work is arranged according to seasons so that live material may be used in connection with most of the exercises. While the manual is intended, primarily, for use in the Chicago region it may be easily adapted for use with materials of any other region. While references are given for the use of books in connection with the work, the studies are made from specimens of the animals rather than from books.

Much of the material has been in use, in one form or another, for some time in the laboratories of the authors. The course as outlined in the manual is the result of a recent reorganization of the work in zoology in the Chicago high schools. The unitary arrangement has been chosen as best suited to the development of understandings of the major ideas of the high school course in zoology. It is the kind of course which should develop desirable life interests without sacrificing the logical organization of the subject on the basis of principles.

The course is recommended not only to those teachers who desire a ready-made, tried course, but also to those who are interested in curriculum revision in science.

JEROME ISENBARGER

Modern Business Geography, by Ellsworth Huntington Research Associate in Geography, Yale University, and Sumner Cushing, late Head of the Department of Geography, State Normal School, Salem, Mass. Cloth 8 vo. viii+352 pages, 185 maps and illustrations. Price $1.96, subject to the usual discount. World Book Co.

A thoroughly revised edition of a text which has been used in the seventh, eight and ninth grades. The book is organized into four parts dealing respectively with (1) Primary Production, (2) Transportation, (3) Manufacturing and (4) Consumption. Products are not discussed by regions but on the broader economic basis. Teachers will be particularly interested in the large number of interest-stimulating problems, questions, and exercises given at the end of each chapter. There is also a wealth of statistical material. The 101 economic maps and 84 half-tone illustrations (which include some valuable airplane views) adequately amplify the text and supply much information necessary for working out the problems proposed at the ends of the chapters. The abundance of this material makes possible a flexible use of this text. It can be used in the half-year course by omitting some of the material or in the whole year course if all the work is carefully done.

Teachers who are using this text recommend it highly because of the attractive way in which the problems of the day are pointed out and pre-

sented. The point of view is one which will stimulate the student to new and to some extent original investigation.

K. U.

Appleton's Standard School Atlas, by George Philip F.R.G.S. and V. C. Finch, Ph.D. Professor of Geography in the University of Wisconsin. xxviiii+63 pages, including index. D. Appleton & Co. 1932. Price $1.50.

This atlas has been edited with the hope that it will be a distinct contribution to the teaching of geography in the intermediate and junior high school grades. It furnishes the essential maps, revised up- to-date, in compact form, and at a reasonable price. Throughout the atlas the physical aspect is emphasized. Political maps are shown on a physical background. However there is a large political map of the world with insets of certain places. The shades and gradations of coloring used on all the maps—climatic, physical, economic, industrial—are pleasing to the eye and yet clearly distinguishable. Statistical maps which are soon out of date are omitted. Maps dealing with the natural environment supplement the physical maps. Overcrowding has been avoided—yet the important names are present. Clearness and legibility have been ensured by the use of distinctive types of lettering and the classification of symbols. Every name on the maps is given in the index with its longitude and latitude.

One of the most valuable features of the introduction is the clear and concise and well illustrated explanation of map projections. Much good advice on the function of an atlas is also given. There is a series of exercises on Adventures in Map Reading that is an excellent introduction of the pupil to the atlas. Much insight into the pupil's needs as well as an understanding of the proper psychological approach is shown in these cleverly worked out adventures. All teachers of geography will be interested in this valuable contribution which has been sponsored by one of the leading cartographers and teachers.

K. U.

Optique Geometrique Elementaire, by M. Ginat, Professor at the Lyceum of Havre, former student of the Ecole Normale Superieure. Paper. Pages 68. 15.5×24 cm. 1932. Editions Bourrelier-Chimenes, 78, Boulevard Saint-Michel, Paris.

The small volume of M. Ginat is a notable contribution in the right direction for the development of the scientific secondary education in France along experimental lines. The French secondary school instruction, in many respects unsurpassed in the realm of the purely theoretical subjects, suffers in experimental subjects because of the lack of individual experimental work. One who is familiar with the French educational traditionalism and classicism knows that even the slightest change in the educational curriculum has been the result of long deliberation and recognized need.

Therefore, the trend toward individualized experimental work in French schools is of special significance to the American educator today, when a number of educational reformers in a strange association with that class of people who call everything above the three R's fads and frills try systematically to eliminate individual experimental work in favor of the superficial demonstrations by the instructor.

Professor Ginat offers a number of conclusive arguments justifying the need of that change. His arguments are convincing. He shows, for instance, that one of the greatest defects of instruction in the French schools is their

low output principally due to the ancient magistral form of teaching. In this form of teaching, he points out, there exists an almost insurmountable barrier between the instructor and the student; and whenever a communication is established it is generally from the instructor to the student and very rarely in the inverse direction. It seems, he concludes, that this is due to the collective nature of the work and the first remedy is to be found in the individualization of experimental work, graphical construction and calculation. Of course, the interpretation and discussion of experiments can be made collective.

The book consists of three chapters. The first and second deal with the arrangements of the laboratory and the indispensable rudimentary instruments. The third and most important chapter is given over wholly to exercises which cover systematically all the phases of elementary geometrical optics.

This chapter is subdivided into sixteen units each containing several exercises, in all fifty-eight. Some experiments which usually are not found in American manuals are:

(a) an elementary experiment illustrating the principle of the optic ever.

(b) an experiment showing the construction of real images due to a virtual object in a plane mirror.

(c) the study and construction of successive images in a system of plane mirrors.

(d) the Reusch construction for the determination of index of refraction.

(e) an experiment dealing with total reflection and determination of the critical angle.

At the end of most of the units will be found many extremely interesting and practical problems of varying difficulty many of which can find a place in college textbooks. The diagrams are helpful and numerous examples are given for the systematic tabulation of the data. To the American instructor actively engaged in the development of teaching the elements of geometrical physics this small textbook undoubtedly could be of much value.

PH. A. CONSTANTINIDES

Elementary Mathematical Analysis, by Mayme Irwin Logsdon, Associate Professor of Mathematics, The University of Chicago. Vol. I. Pages xiv+212+32. 16×23.5 cm. 1932. Price $2.25. Vol. II. Pages ix+188. 16×23.5 cm. 1932. Price $1.75. McGraw-Hill Book Co., Inc., 330 West 42nd Street, New York.

During the past two decades the feeling has been growing among teachers of college mathematics that our freshman course should be organized for the purpose of giving our students some appreciation and understanding of the significance of mathematics in our modern civilization. We cite as evidence of the truth of this statement the numerous texts on elementary mathematical analysis for freshmen that have been written during this period. These texts stress the functional phase of quantitative thinking and attempt to develop in the mind of the student some mathematical insight and appreciation for mathematics not only as a mode of thought but also as an instrument used by scientists and technicians in handling quantitative problems. Such texts place less emphasis on manipulation and the formal aspects of mathematics than do those of the standard type.

A course organized on a functional basis may well include the elementary notions of the calculus. These elementary principles can be used to sim-

plify the treatment of many topics and to solve some of the simple problems that arise in science and industry. The student thus gains some appreciation of the important role mathematics plays in practical affairs. Many teachers believe that such a course, whether it be terminal or basic, has more value for the student than our historic standard courses.

Professor Logsdon has developed in these two volumes a course which contains the essentials of all the topics usually treated in the freshman year. By treating the topics from the standpoint of functionality she has avoided the compartment type of treatment which is characteristic of our standard courses. By introducing the methods of elementary calculus she has enriched the course and made it much more significant for the student than it would have been otherwise.

The first volume is designed to give the student some of the elementary notions of mathematics and their relation to his everyday life. We find fourteen chapters in this volume. The first deals with the concepts of variable and function. The following chapters deal with trigonometric functions, logarithmic and exponential functions, properties of elementary functions, simultaneous linear equations, polynomials of the first, second and higher degrees with applications of maxima and minima, and rational functions.

The second volume continues and extends certain topics found in the first volume and adds additional topics which may be needed in the formal course of the calculus. We find sixteen chapters which cover, among others, the following topics: the number system of elementary mathematics, solution of equations, trigonometric analysis, ellipse, hyperbola, parabola, transformation of coordinates, polar coordinates, progressions, mathematical induction applied to the binomial theorem, permutations and combinations, partial fractions, and probability.

We feel that the student who has completed this course should have a keener mathematical insight and appreciation than he would have obtained from a standard course. Accordingly he should be better prepared for the formal calculus.

J. M. KINNEY

Elementary Differential Equations, by Lyman M. Kells, Ph.D., Assistant Professor of Mathematics at the U. S. Naval Academy. Pages ix+184. 13.5×20.5 cm. 1932. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York, N. Y. Price $2.00.

In this text we find a course in Differential Equations which may follow nicely the usual course in Differential and Integral Calculus. The theory is carefully presented and the problems are carefully graded. We find practical applications introduced early in the course. These applications to geometry, physics, and mechanics occur frequently throughout the text. There is an abundance of problems of which the most difficult will hold the interest of the honor student.

J. M. KINNEY

Creative Science, published by the Lake Shore Press with a 1932 copyright and 382 pages has an anonymous author who calls himself A Modern Job.

The central theme throughout the volume consists in an attempt to establish a new religious philosophy and to base the propositions of this philosophy upon the generalizations of natural scientists. The author claims that "Creative Science" is A New Religious Philosophy with a Scientific Basis. However, it is not the purpose of this Modern Job to

bring about the conclusion that religion is a thing located in test tubes or in biological viscera. It is apparently his purpose to show that the real "Creative" science comes about in the procedures of the philosopher who is interested in putting the world together after the natural scientists have discovered its parts. The reader will therefore find quotations from Bergson, Hegel, and Jesus along with quotations from Breasted, Einstein, and Galileo.

The first part of the discussion consists in an attempt to break the common man free from the clutches of traditional thinking; the latter part attempts to free him from his tomb of materialism. Thus, The Modern Job says, "The new religion, whatever it may be, cannot be built upon any of the theological foundations of the past. It should be possible to evolve a religion that will satisfy the needs of the human heart without insulting the intellect." Then later in describing the procedures for enjoying the fruits of "Creative Science," he says, "The initiate should form a new vocabulary.—As we express our thoughts in words, and as we have been given wrong meanings to words all during our life, we must change the meanings of certain words in order to change our thinking about the things such words represent. Much of what we may object to in the church may be due to the fact that symbols offend because we are blinded to their functions. Remember that a conclusion is only a temporary landing upon a stairway of intellect, and that a new flight of steps may be uncovered to lead to greater heights."

The book closes with a credo consisting of six suggested beliefs including God, Jesus, the Holy Ghost, mind, virtue, and eternal life, which perhaps is a satisfying climax to a discussion which began with materials of nature made of electrons, etc., then followed with philosophical rationalizations and ended with a flight to the less controversial, spiritual world of belief, faith, prayer, and freedom.

The Modern Job will have accomplished considerable if he influences the laboratory scientist to become less of a groundhog and enjoy more of the fruits of at least the scientific method if not those of philosophy, and the tranquility brought by spiritual belief. There is a hint here for the makers of college curriculums to the effect that students of engineering, etc., should be encouraged by their laboratory professors to drink also from the spirits of psychology, philosophy, poetry, and religion.

G. W. GIFFORD

Recent Advances in Atomic Physics, by Gaetano Castelfranchi, Professor in the High School for Engineers in Milan; Approved Translation by W. S. Stiles, Scientific Assistant, The National Physical Laboratory, Teddington and J. W. T. Walsh, Principal Assistant, The National Physical Laboratory, Teddington. Volume I, Atoms, Molecules and Electrons. Cloth. Pages xii+360+12. 111 Illustrations. 13×20 cm. 1932. Volume II, Quantum Theory. Cloth. Pages xii+400+12. 79 Illustrations. 13×20 cm. 1932. P. Blakiston's Son and Company, Inc., 1012 Walnut Street, Philadelphia, Pa. Price per Volume $4.00.

These two volumes aim to give students of physical science a general knowledge of the development of atomic physics. They could well be used as the basis of a college course, or for professional study by teachers who have not been able to keep up with the progress of research.

Volume I starts with a review of some basic topics, a knowledge of which is necessary for an understanding of what follows. These topics include the growth of the atomic theory, the classification of elements, the beginning of the idea of an atom of electricity, the wave theory of light and the experiments and instruments which established this theory, the

study of spectra, etc. These introductory chapters are followed by chapters on the kinetic theory of gases, fluctuations, electrons and positive rays, isotopes, X-rays and the atomic number, crystals, radioactivity and the atomic nucleus. In a book of this size it cannot be expected that the treatment will be complete. Numerous gaps occur which the student must fill if he wishes to get a comprehensive view, and this demands considerable previous acquaintance with the subject. The principal experiments which laid the foundations for the theoretical development are thoroughly described and their significance pointed out. In most cases the student is left to work out the mathematical calculations from the mere outlines given if he wishes to go deeply into the study.

Volume II, a discussion of the quantum theory, consists of nine chapters as follows: (I) Thermal Radiation and Quantum Theory, (II) Spectroscopy, Bohr's Theory and the Energy Levels of the Atom, (III) Stark and Zeeman Effects. Multiplet Lines. The Spinning Electron, (IV) Specific Heat, (V) The Photoelectric Effect. The Reverse Effect. Photoelectric Cells and Their Applications, (VI) The Compton Effect. Light Quants, (VII) Magnetism and the Quantum Theory, (VIII) Wave Mechanics and Quantum Mechanics. Applications, (IX) The New Statistics. Applications.

These two volumes cover the entire field of atomic physics in a manner designed to give a rather rapid comprehension of the new physics, but teachers and students who have acquired a fair knowledge of classical physics without giving considerable attention to the developments of recent years will find these books are for serious study and not for casual reading. Those who want to master the subject will find them valuable both for the actual content and for the bibliography following each chapter.

G. W. W.

Radio Physics Course, An Elementary Text Book on Electricity and Radio by Alfred A. Ghirardi in charge of Department of Radio Communication and Applied Electricity. Hebrew Technical Institute, New York City. Second Edition Revised and Enlarged. 508 Illustrations. Cloth. Pages xiv+972. 16.5×22.5 cm. 1932. Radio Technical Publishing Company, 80 Fifth Avenue, New York, N. Y. Price $3.50.

This book is a complete course in radio. All the knowledge of sound, light, electricity, atomic structure, electron theory, etc. that is needed for an understanding of radio theory is given. This material is introduced as needed thus making it an integral part of the course. The book consists of thirty-six chapters, each being sub-divided into topics and followed by a list of review questions covering the main points of the chapter. This arrangement supported by more than five hundred well-labeled diagrams and pictures, and text material which gives accurate, understandable descriptions and explanations makes the book an ideal textbook for classroom use or home study. Every phase of radio needed for a basic understanding and a practical working knowledge of the subject is taken up in detail. It is completely up-to-date, including the latest developments in television and sound motion pictures. No radio library is adequate without this book.

G. W. W.

Experimental College Physics, A Laboratory Manual, by Marsh William White, Associate Professor of Physics, The Pennsylvania State College. First Edition. Cloth. Pages xi+283. 14.5×23 cm. 1932. McGraw-Hill Book Company, 330 West 42nd Street, New York, N. Y. Price $2.50.

Experimental College Physics is a laboratory textbook not merely a labo-

ratory manual. It gives directions for performing a large number of experiments, fifty-eight in all. The theory of each is developed, the apparatus required is described, and definite detailed directions for manipulation are given. The directions tell what to observe, what errors are likely to occur and how to avoid them. Questions are asked to keep the student thinking about the processes and the results. Each experiment is followed by a list of review questions and by a set of numerical problems based on the principles and applications of the experiment.

The experiments are those that have become standard in general physics. In most of these the latest improved pieces of apparatus are used but a few exceptions to this principle are noticeable; e.g. none of the recent "free fall" types of apparatus are used in the uniformly accelerated motion experiment. The illustration for this experiment is out of place; Fig. 2, page 37 and Fig. 1, page 73 should be interchanged.

Of the major divisions of the subject electricity is emphasized rather more than usual and heat is under-emphasized. The appendix contains most of the tables necessary except a table of logarithms. This seems to the reviewer to be a very unfortunate omission. The wire table is too much abbreviated; a table giving gauge numbers and diameters of all sizes of wire in common use in the laboratory is convenient for reference and requires only a page. For convenient use the two pages required for the table of natural sines should face each other; the same criticism holds for the tangent table. Since students must be taught to record data systematically some of the experiments should give suggestive tabular outlines for recording data and results. Instructions for graphing would also be included in the ideal manual.

G. W. W.

SCHOOL OR JAIL

One of the most startling bits of recent new is an announcement from the National Education Association.

That organization did some figuring and found out that while it costs $3,000 a year to keep a man in prison, it costs only $100 a year to keep a child in school. The nation spends about a billion and a half a year on its 500,000 prisoners; it spends only two billion and a half to educate its 26,000,000 school children.

It would be a good thing if that information could be placed before every American public official who has anything to do with school budgets. It is the most eloquent preachment against cutting such budgets that could possibly be imagined.

Educated men and women do not often find their way into penitentiaries. There are exceptions to this rule, of course; but any social worker, police official or prison warden can tell you that the youngster who goes through school and gets a decent chance to train and broaden his mind is not very apt to become a law-breaker when he grows up.

The great recruiting ground for the underworld is the place where youngsters break off their schooling before they have had enough of it to profit by it.

That, of course, is only another way of saying that the public school system is about as good a crime preventive as we have. And it is an amazingly cheap one, all things considered. It is, at any rate, infinitely cheaper than our prison system, which is no preventive at all.

These times demand strict economy in government. No city or state can afford any unnecessary expenditures. But the money we spend on our schools is not an unnecessary expenditure nor is it an expenditure which is

unduly high. Compared with that other little item—the cost of taking care of criminals—it is very low indeed.

The school budget, in short, is just about the last place to wield the blue pencil. Economy is all right, but elimination of necessary departments is all wrong. One hundred dollars a year per child, invested now, can save us $3,000 a year per criminal a little later.—*Waukegan News Sun.*

U. S. NEARLY SELF-SUFFICIENT IN RAW MATERIALS, LACKING COFFEE, TEA, AND TIN

No other country in the world can be so self-sufficient as the United States, declares Francis P. Garvan, president of the Chemical Foundation, New York City, in a letter read into the Congressional Record by Senator Henry D. Hatfield of West Virginia.

Today, lacking only the five essential products of coffee, tea, tin, rubber and sisal, Mr. Garvan declares only a few years more are needed to make America absolutely independent in regard to her demands for these raw materials as well as all others.

Formerly we have been more or less at the mercy of foreign trade cartels in potash, manganese, camphor, rubber, silk, iodine, long staple cotton, nitrates, coffee, tea and tin.

"Today," writes Mr. Garvan, "the chemist has sprung us loose from all these controls, with the exception of the five products named above:

"1. Potash has been discovered in Southwestern states in ample quantity to supply the United States. Its ability to compete with the potash from the cartels of Germany and France is only a question of freight rates. The ownership of these beds of potash, however, should be watched by the government.

"2. Manganese. Charles H. Herty, Jr., son of Dr. Chas. H. Herty, has worked out a process whereby our own ores can be used, and thus we become independent of Russia.

"3. Camphor. The Du Pont Company have just finished their plant sufficient to supply the needs of the country with synthetic camphor.

"4. Rubber. Synthetic rubber has been perfected by the Du Pont Company, and is being produced in a semiworks plant. Of course we cannot produce rubber to compete at the present price of four cents, but a possible recurrence of the Stevenson Act monopoly is at an end . . . (Price reached $1.21 in 1925) . . . By discovery of our chemists, we are assured that the price will never again go above 20 cents without meeting the competition of American synthetic rubber, and this limit may well be lowered by the usual progress in lessening chemical costs.

"5. Rayon can readily take the place of silk.

"6. Iodine is now being produced by the Dow Chemical Company from oil wells. This production can easily, in the case of necessity, be expanded to cover our needs.

"7. The possibility of growing an ample supply of long staple cotton has been developed under the guidance of our Department of Agriculture.

"8. And now comes nitrates from the air. Ten American plants are producing and stand ready to produce the entire necessities of this country in peace and war . . . at price to equal the costs of the world. The farmer today is getting his nitrates for $22 a ton, against $36 today paid by the German farmer and against the former price of $90 during the war and $48 in 1926. . . .

"There remain only coffee, tea and tin. Coffee and tea are not necessities and their synthesis is being worked on by our chemists. For tin there are many substitutes in alloys and other products."—*Science Service.*

NEANDERTHAL CHILD SEEN AS FATHER OF MODERN MAN

The child of the Neanderthal race is seen as the father of men of the modern race by two Oxford anthropologists, L. H. Dudley Buxton and G. R. de Beer. In a note to the editor of the British scientific journal, Nature, they call attention to the significance of "modern" characters of the back of Neanderthal child's skull found at Gibraltar by Miss Dorothy Garrod, noted English student of ancient man.

"The resemblance between Homo sapiens and Homo neanderthalensis suggests that the former may have been descended from the latter by a progressive retention into adult life of characters present in the young stages of the ancestor," the two Oxonians state.

Evolution by such means is sometimes called "fetalism," but the name "pedomorphosis" is suggested as more appropriate. The latter term, from the Greek, implies a mode of form changes determined by the structure of the child.

The American anthropologist, Ales Hrdlicka of the U. S. National Museum, has also arrived at the conclusion that modern man is the offspring of Neanderthal man, though he did so from other lines of investigation.—*Science Service.*

All eyes are open or are opening to the rights of man, the general spread of the light of science has already laid open to every view of palpable truth that the mass of mankind has not been born with saddles on their backs for a favored few, booted and spurred, ready to ride them legitimately, by the grace of God.—THOMAS JEFFERSON.

Exercise Book in High School Biology

By J. Glenn Blaisdell

This laboratory workbook, just published, lightens the work and saves the time of both teacher and student. The stimulating exercises and abundance of review material insure thorough learning. New interest is added by the seasonal list of individual projects. For classes in first year biology this book provides a practical method of increasing the efficiency and effectiveness of laboratory work.

Send for complete description

WORLD BOOK COMPANY

Yonkers-on-Hudson, N. Y., 2126 Prairie Ave., Chicago

SCIENCE QUESTIONS

March, 1933

Conducted by Franklin T. Jones, 10109 Wilbur Avenue, Cleveland Ohio

Readers are invited to co-operate by proposing questions for discussion or problems for solution.

Examination papers, tests, and interesting scientific happenings are very much desired. Please enclose material in an envelope and mail to Franklin T. Jones, 10109 Wilbur Avenue, Cleveland, Ohio.

NOBLE OR HUNTER?

617. *Proposed by Joseph A. Nyberg, Hyde Park High School, Chicago, Ill.*

"Here's a problem like the 'Smith-Jones-Robinson' affair but simpler. I have made great use of it in Geometry Classes."

A, *B*, and *C*

Three gentlemen *A*, *B*, and *C*, engage in a conversation; from it we are to decide whether each is a Noble or a Hunter. We have two theorems to guide us:

Theorem 1. A Noble always tells the truth.

Theorem 2. A Hunter always lies.

A begins the conversation and says either "I am a Noble" or he says "I am a Hunter." We do not know which of these two statements he made.

B says to *A* "You said you were a Hunter."

B says to *C* "You are a Noble."

C says to *A* "You are a Noble."

PORTRAITS OF GREAT SCIENTISTS

618. *Proposed by Matthew Halverson, Custer County High School, Miles City, Montana.*

Can you suggest where I can obtain a large portrait of Galileo which I can frame and hang in my class room?

I will be very grateful for this suggestion.

AN ANSWER

615. Question:—Can a "Sugar Eat" be scientific?

Answer by Wm. G. Vinal

To prove that it can I submit a "Test on Maple Sugar." (See Question 619.) Further, it took me "all the morning to coin, arrange and type but believe it worth the effort." *Cap'n Bill.*

A DINNER FOR AN ANSWER

QUESTIONS ON THE MAPLE SUGAR INDUSTRY: A UNIT OF STUDY

619. *Proposed by Wm. G. Vinal, Ph.D., School of Education, Western Reserve University.*

This is a pre-test for those planning to attend the sugar bush party at Western Reserve Academy March 18, 1933. In fact anyone sending correct answers for the test to W. G. Vinal, Western Reserve University before

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March 18th will be given a complimentary ticket to the "Sugaring off" supper. Some of you might like to turn the questions over to your science class and bring the highest scorer. If you are pedagogically meticulous, I dare say that you can find biology chemistry, physics, mathematics, history, literature or "what need you" within the test. The correct answers will be given at the "Sugaring off" and, if interest seems to demand it, they will be printed in the next issue of SCHOOL SCIENCE AND MATHEMATICS. In the meantime the fun is all yours.

1. Who wrote the following:

"I wonder if the sap is stirring yet,

. . . . . .

If frozen snowdrops feel as yet the sun.

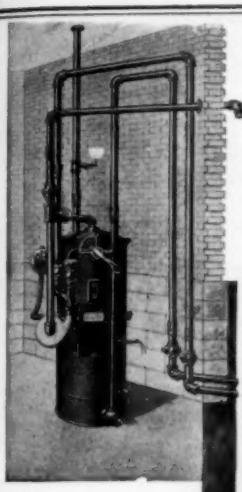
. . . . . .

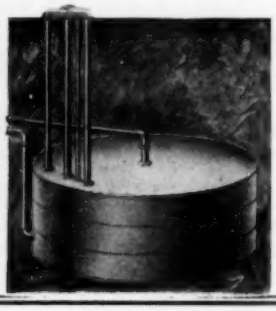
I still am sore in doubt concerning Spring."

2. Anyone going to the "Sugar Bush" ought to be versed in "Sugar Bush" parlance.

What do the following terms mean? "Treacle" "First run" "Season" "Stone-boat" "Caldron kettles" "Sugar off"

3. When was maple sugar a necessity and when did it become a luxury?
4. What is the real sugar tree?
5. What part of the tree is the sugar factory?
6. Name a state in which the maple is the state tree.
7. How much maple sugar is made in Europe?
8. For what purpose do they use the axe in the Maple Sugar camp?
9. What is ideal maple sugar weather?
10. What are two distinguishing characteristics of maple sugar buds?
11. What is the purpose of maple sugar?
12. Of what material was the sap spout of the Indian Days and of the present day?
13. Does the tapping of the tree leave a wound that will usually be infected by fungi?
14. What was the Indian method of concentrating the sugar?
15. What is the longest tapping season?
16. From what direction does the sap come?
17. On what side of a tree does the sap flow first?
18. What causes the sap to flow?
19. Name four animals (Other than man) that have discovered that maple sap is good.
20. What were the earliest vessels for collecting maple sap?
21. About how much sap is required to make one quart of sirup?
22. What should be the size and position of the hole for sap flow?
23. Through what part or parts of the tree does sap flow?
24. What is the purpose of a "neck-yoke"?
25. What is the advantage of locating a sugar house on a slope?
26. Why is skimming necessary?
27. How is the "evaporator" prevented from boiling over?
28. How many pounds should maple sirup weigh to the standard United States gallon?
29. If a utensil has a full gallon when the liquid is hot will it be a full gallon when cold? Why?
30. Why did "sugaring off" always occur at night in colonial times?
31. From what maples can sugar be made?
32. How is "maple wax" made?
33. What is the most important New England state in the production of maple sugar?





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